



ADDENDUM 002

RFQ015 – Structure Modifications

- Added – RFI Response
- Revised – Attachment A1

January 17, 2014

RFQ #	Bid Due	RFI	Response
015	1/22/2014	Has the Bridge duct bank work been moved from RFQ 021 to RFQ 015?	As stated in the ductbank solidcation letter scope, underdeck structural conduits will be installed by others.
015	1/22/2014	Has the bridge lighting electrical conduit work been moved from RFQ 019 to RFQ 015?	As stated in the ductbank solidcation letter scope, traffic signal and street light conduits will be installed by others.



ADD-1	Addendum #1 Dated January 7th, 2014 (initial acknowledgement of receipt)	_____	_____
		Initials	Date
ADD-2	Addendum #1 Dated January 17, 2014 (initial acknowledgement of receipt)	_____	_____
		Initials	Date

Bid Item #	Description	Quantity	Unit of Measure	Unit Price	Total Price
MAIN STREET VIADUCT OVER KCTRR					
M-1	Modify Existing Bridge Expansion Joint (ST104)	458	LF	\$	\$
M-2	Modify Existing Bridge Expansion Joint (ST105)	122	LF	\$	\$
M-3	Modify Longitudinal Joint (ST105)	1,056	LF	\$	\$
M-4	Modify Median Drain (ST106)	18	EA	\$	\$
M-5	Raise Existing Scupper (ST107)	7	EA	\$	\$
M-6	Replace Existing Scupper (ST108)	4	EA	\$	\$
M-7	Replace Existing Inlet (ST108)	1	EA	\$	\$
M-8	Track Drain Connection to Scupper (ST109)	1	LS	\$	\$
M-9	Joint Track and Bridge Drain (ST110)	3	EA	\$	\$
M-10	Preformed Joint Filler at North Abutment	58	LF	\$	\$
M-11	Mudjack Approach Slabs	1	LS	\$	\$
M-12	Remove Existing Barrier	163	LF	\$	\$
M-13	OCS Plate Foundations Type A (ST111)	5	EA	\$	\$
M-14	OCS Plate Foundations Type B (ST111)	-	EA	\$	\$
M-15	OCS Plate Foundations Type C (ST111)	7	EA	\$	\$
M-16	OCS Blister Foundations Type D (ST111)	8	EA	\$	\$
M-17	Cast in Place Barrier (ST114)	904	LF	\$	\$
M-18	CIP Barrier OCS Blister Foundations (ST114)	10	EA	\$	\$
M-19	Turnout Deck Demolition (ST116)	1	LS	\$	\$
M-20	Bridge Conduits (Z101 - Z103A)	1	LS	\$	\$
M-21	Track Flagging/Railroad Permits	1	LS	\$	\$
M-22	4 1/2" Concrete Wearing Surface	8,230	SY	\$	\$
M-23	Integral Curb & Sidewalk (Type CS)	200	LF	\$	\$

DELAWARE STREET VIADUCT OVER INTERSTATE 70					
D-1	Mudjack Approach Slabs	1	LS	\$	\$
D-2	Preformed Joint Filler at Abutments	120	LF	\$	\$
D-3	Mounting Blister Foundations (ST118)	9	EA	\$	\$
D-4	Bridge Conduits (Z120, Z121)	1	LS	\$	\$
D-5	4 1/2" Concrete Wearing Surface	1,540	SY	\$	\$

	Authorized Representative for this Bid Package who is authorized to sign the KCSCIV Attachment A for this bid.			
Name - Print	Signature	Initials	Date	

Inclusions:	
1	Furnish all labor, equipment, materials and supplies for the bid items listed herein and per the Prime Contract documents / Specifications
2	Payment based on actual quantity/services rendered.
3	This project is a Buy America project and subcontractor is required to submit material certifications.
4	This contract will be subject to a 5% retention until project close out.
5	All mobilizations necessary to complete work in order to maintain project-wide schedule.
6	Provide and maintain continuous access to businesses, homes, parking lots, sidewalks, temporary pedestrian bridges and driveways as required.
7	Coordination with the designer/City of Kansas City/third party utilities/Kansas City Streetcar Constructors including their designated QC Manager(s), technicians and inspectors for all required tests and inspections during installation.
8	Submittals and resubmittals per the contract documents.
9	Compliance with Kansas City Streetcar Constructors Project QA/QC Plan.
10	Compliance with storm water pollution control regulations and/or KCMO standard and best management practices.
11	Contractor's site specific safety plan and supply of MSDS sheets for all products before starting work with specified products.
12	Coordination with Contractor and other subcontractors to complete work in accordance with the Project Schedule.
13	Contract insurances including General Liability, Worker Compensation, Automobile, and Railroad (if applicable) per contract requirements.

INITIAL: _____

DATE: _____



14	Payment and Performance Bonds
15	Street sweeping, general housekeeping of work zones and storage sites.
16	Temporary water and power, contractors on-site yard facility, employee parking as required per scope of work.
17	All trucking, offhaul and fees. Includes water trucks as well.
18	Include any and all applicable taxes.
19	Coordination with track construction and systems.
20	Submittal of Best Management Practices (BMP) and residue disposal plan for slurry and debris containment during construction including identified "no discharge zones." All requirements outlined in the plans are inclusive to the unit prices as listed above.
21	Operations may be suspended by the Engineer during rainfall or freezing temperatures. Provisions may be required, such as heaters, blankets, and tents to maintain the project schedule.
22	Frame and grate modifications including any touch up painting, welding, and shimming.
23	All drilling, dowelling, and epoxy as called out in the project drawings, including any additional as a result of damage during demolition.
24	Item M-9 is for the pipe connection and pressure injected cavities thru the deck and all work under deck. Track drain frame and grate are excluded and will be installed during track construction.
25	Includes all rebar, bolts, plates, washers, pressure injection of cavities, concrete, and joint filler for foundation and barrier
26	Epoxy rebar repairs in accordance with MoDOT Standard Specification Section 710
27	Contractor will be responsible for all railroad coordination, included permits, track flagging, and work plans. Permit fees and track flagger costs will be direct billed against the listed Lump Sum item.
28	Bridge conduits shall include all required expansion conduits, hangers, struts, all thread, boxes, attachments, etc., and coordinate the mandrelling and tagging with mainline ductbank
29	Bridge conduits shall include attachments to encased PVC conduits at bridge side wall.
30	Bridge conduits will include any coring, deck penetrations, nipples, etc required.
31	Bridge conduits include cable trough on Z101B.
32	Coring drilling and installation of negative return conduits on sheet Z103A notes 10 & 11
33	New concrete deck overlay shall be class B-2 concrete. FC' = 4,000 PSI In accordance with section 501 of the MoDOT standard specifications.
Exclusions:	
1	Initial project control survey
2	Quality Control Testing (coordination is required)
3	Traffic Control (other than track flaggers. Track flaggers are included)
4	Track Construction and track concrete encasement
5	Item M-9 track frame and grate.
6	Z103A conduits and boxes other than those listed in inclusion #32
7	Hazardous Waste Removal and Disposal
8	8ft wide concrete track slab to be installed by others.



ADDENDUM 001

RFQ015 – Structure Modifications

- Revised – Bidders Checklist
- Revised – Attachment A1
 - Added Bid Item M-22 – Concrete Deck Overlay
 - Added Bid Item M-23 – Integral Curb & Sidewalk (Type CS)
 - Added Bid Item D-5 – Concrete Deck Overlay

January 7, 2014

BIDDERS CHECKLIST – STRUCTURE MODIFICATIONS

KANSAS CITY DOWNTOWN STREETCAR

PROJECT NO. 89022000

*(Initial to acknowledge receipt of documents and return this form with final bid pricing)****

- _____ Scope / Bid Package Narrative and Solicitation Information *
- _____ Bid Schedule - Attachment A1 **(Revised January 7, 2014)** ***
- _____ Pre-Qualification/Evidence of Competency to Perform Letter – Structural Modifications (Attachment B) **
- _____ Pre-Contract Bidder's Certification Form (Attachment B1) ***
- _____ Anti-Collusion Affidavit (Attachment C) ***
- _____ Payment Bond (Attachment D1) *
- _____ Performance Bond (Attachment D2) *
- _____ Sample Insurance Certification (Attachment D3) *
- _____ Contractor Utilization Plan/Request for Waiver (Attachment E-1) ***
- _____ Request for Modification, Replacement or Termination of DBE Project Participation (Attachment E-2) *
- _____ Subcontractor Monthly Utilization Report (Attachment E-3) *
- _____ Schedule of Participation by Contractor & Subcontractor (Attachment E-4) ***
- _____ Workforce Analysis Report (Attachment F-2) *
- _____ Affidavit of Primary Participants Compliance with Section 285.500 RSMO, ET SEQ. Regarding Employee Eligibility Verification (Attachment G-1) ***
- _____ Affidavit of Lower-Tier Participants Compliance with Section 285.500 RSMO, ET SEQ. Regarding Employee Eligibility Verification (Attachment G-2) ***
- _____ Certification of Primary Participants Regarding Debarment, Suspension, and Other Ineligibility and Voluntary Exclusion (Attachment H-1) ***
- _____ Certification of Lower-Tier Participants Regarding Debarment, Suspension, and Other Ineligibility and Voluntary Exclusion (Attachment H-2) ***
- _____ Certification of Primary Participants Regarding Restrictions on Lobbying (Attachment I-1) ***
- _____ Certification of Lower-Tier Participants Regarding Restrictions on Lobbying (Attachment I-2) ***
- _____ Buy America Certification Form (Attachment J) ***
- _____ Sample of Request for Interpretation (RFI) Form (Attachment K) *
- _____ Letter of Intent to Subcontract (DBE Form) (Attachment L) *
- _____ Sample of Subcontractor Affidavit for Final Payment (Attachment M) *
- _____ Project Exemption Certificate (Form 5060) (Attachment N) *
- _____ KCSC Project Safety Requirements (Attachment P) *
- _____ Wage Control Documents *
- _____ KCMO General Conditions (Attachment Q1) *
- _____ KCMO Supplementary Conditions Project # 89022000 (Attachment Q2) *
- _____ "SAMPLE" Kansas City Streetcar Constructors (KCSC) Subcontract Agreement *
- _____ Project Workforce Monthly Report (Attachment R1)*
- _____ Company-Wide Workforce Monthly Report (Attachment R2)*
- _____ Plans – 100% Design Submittal (Volumes 2 & 4) **(on KC Planroom)** *
- _____ Project Specifications – 100% Design Submittal **(on KC Planroom)** *

*** Item is for information/sample only and does not need to be returned**

**** Must be returned, completed with the Pre-Qualification**

***** Must be returned, completed, with Final Bid Pricing**

[20 Documents]

[1 Document]

[13 Documents]



ADD-1		Addendum #1 Dated January 7th, 2014 (initial acknowledgement of receipt)		Initials		Date	
Bid Item #	Description	Quantity	Unit of Measure	Unit Price	Total Price		
MAIN STREET VIADUCT OVER KCTRR							
M-1	Modify Existing Bridge Expansion Joint (ST104)	458	LF	\$	\$		
M-2	Modify Existing Bridge Expansion Joint (ST105)	122	LF	\$	\$		
M-3	Modify Longitudinal Joint (ST105)	1,056	LF	\$	\$		
M-4	Modify Median Drain (ST106)	18	EA	\$	\$		
M-5	Raise Existing Scupper (ST107)	7	EA	\$	\$		
M-6	Replace Existing Scupper (ST108)	4	EA	\$	\$		
M-7	Replace Existing Inlet (ST108)	1	EA	\$	\$		
M-8	Track Drain Connection to Scupper (ST109)	1	LS	\$	\$		
M-9	Joint Track and Bridge Drain (ST110)	3	EA	\$	\$		
M-10	Preformed Joint Filler at North Abutment	58	LF	\$	\$		
M-11	Mudjack Approach Slabs	1	LS	\$	\$		
M-12	Remove Existing Barrier	163	LF	\$	\$		
M-13	OCS Plate Foundations Type A (ST111)	5	EA	\$	\$		
M-14	OCS Plate Foundations Type B (ST111)	-	EA	\$	\$		
M-15	OCS Plate Foundations Type C (ST111)	7	EA	\$	\$		
M-16	OCS Blister Foundations Type D (ST111)	8	EA	\$	\$		
M-17	Cast in Place Barrier (ST114)	904	LF	\$	\$		
M-18	CIP Barrier OCS Blister Foundations (ST114)	10	EA	\$	\$		
M-19	Turnout Deck Demolition (ST116)	1	LS	\$	\$		
M-20	Bridge Conduits (Z101 - Z103A)	1	LS	\$	\$		
M-21	Track Flagging/Railroad Permits	1	LS	\$	\$		
M-22	4 1/2" Concrete Wearing Surface	8,230	SY	\$	\$		
M-23	Integral Curb & Sidewalk (Type CS)	200	LF	\$	\$		
DELAWARE STREET VIADUCT OVER INTERSTATE 70							
D-1	Mudjack Approach Slabs	1	LS	\$	\$		
D-2	Preformed Joint Filler at Abutments	120	LF	\$	\$		
D-3	Mounting Blister Foundations (ST118)	9	EA	\$	\$		
D-4	Bridge Conduits (Z120, Z121)	1	LS	\$	\$		
D-5	4 1/2" Concrete Wearing Surface	1,540	SY	\$	\$		
<hr/> Name - Print		Authorized Representative for this Bid Package who is authorized to sign the KCSCJV Attachment A for this bid.		<hr/> Signature		<hr/> Initials	
				<hr/> Date			
Inclusions:							
1	Furnish all labor, equipment, materials and supplies for the bid items listed herein and per the Prime Contract documents / Specifications						
2	Payment based on actual quantity/services rendered.						
3	This project is a Buy America project and subcontractor is required to submit material certifications.						
4	This contract will be subject to a 5% retention until project close out.						
5	All mobilizations necessary to complete work in order to maintain project-wide schedule.						
6	Provide and maintain continuous access to businesses, homes, parking lots, sidewalks, temporary pedestrian bridges and driveways as required.						
7	Coordination with the designer/City of Kansas City/third party utilities/Kansas City Streetcar Constructors including their designated QC Manager(s), technicians and inspectors for all required tests and inspections during installation.						
8	Submittals and resubmittals per the contract documents.						
9	Compliance with Kansas City Streetcar Constructors Project QA/QC Plan.						
10	Compliance with storm water pollution control regulations and/or KCMO standard and best management practices.						
11	Contractor's site specific safety plan and supply of MSDS sheets for all products before starting work with specified products.						
12	Coordination with Contractor and other subcontractors to complete work in accordance with the Project Schedule.						
13	Contract insurances including General Liability, Worker Compensation, Automobile, and Railroad (if applicable) per contract requirements.						
14	Payment and Performance Bonds						
15	Street sweeping, general housekeeping of work zones and storage sites.						
16	Temporary water and power, contractors on-site yard facility, employee parking as required per scope of work.						
17	All trucking, offhaul and fees. Includes water trucks as well.						
18	Include any and all applicable taxes.						
19	Coordination with track construction and systems.						
20	Submittal of Best Management Practices (BMP) and residue disposal plan for slurry and debris containment during construction including identified "no discharge zones." All requirements outlined in the plans are inclusive to the unit prices as listed above.						
21	Operations may be suspended by the Engineer during rainfall or freezing temperatures. Provisions may be required, such as heaters, blankets, and tents to maintain the project schedule.						
22	Frame and grate modifications including any touch up painting, welding, and shimming.						
23	All drilling, dowelling, and epoxy as called out in the project drawings, including any additional as a result of damage during demolition.						
24	Item M-9 is for the pipe connection and pressure injected cavities thru the deck and all work under deck. Track drain frame and grate are excluded and will be installed during track construction.						
25	Includes all rebar, bolts, plates, washers, pressure injection of cavities, concrete, and joint filler for foundation and barrier						
26	Epoxy rebar repairs in accordance with MoDOT Standard Specification Section 710						
27	Contractor will be responsible for all railroad coordination, included permits, track flagging, and work plans. Permit fees and track flagger costs will be direct billed against the listed Lump Sum item.						



28	Bridge conduits shall include all required expansion conduits, hangers, struts, all thread, boxes, attachments, etc., and coordinate the mandrelling and tagging with mainline ductbank
29	Bridge conduits shall include attachments to encased PVC conduits at bridge side wall.
30	Bridge conduits will include any coring, deck penetrations, nipples, etc required.
31	Bridge conduits include cable trough on Z101B.
32	Coring drilling and installation of negative return conduits on sheet Z103A notes 10 & 11
33	New concrete deck overlay shall be class B-2 concrete. FC' = 4,000 PSI In accordance with section 501 of the MoDOT standard specifications.
Exclusions:	
1	Initial project control survey
2	Quality Control Testing (coordination is required)
3	Traffic Control (other than track flaggers. Track flaggers are included)
4	Track Construction and track concrete encasement
5	Item M-9 track frame and grate.
6	Z103A conduits and boxes other than those listed in inclusion #32
7	Hazardous Waste Removal and Disposal
8	8ft wide concrete track slab to be installed by others.

BIDDERS CHECKLIST – STRUCTURE MODIFICATIONS

KANSAS CITY DOWNTOWN STREETCAR

PROJECT NO. 89022000

*(Initial to acknowledge receipt of documents and return this form with final bid pricing)****

- _____ Scope / Bid Package Narrative and Solicitation Information *
- _____ Bid Schedule (Attachment A1) ***
- _____ Pre-Qualification/Evidence of Competency to Perform Letter – Structural Modifications (Attachment B) **
- _____ Pre-Contract Bidder's Certification Form (Attachment B1) ***
- _____ Anti-Collusion Affidavit (Attachment C) ***
- _____ Payment Bond (Attachment D1) *
- _____ Performance Bond (Attachment D2) *
- _____ Sample Insurance Certification (Attachment D3) *
- _____ Contractor Utilization Plan/Request for Waiver (Attachment E-1) ***
- _____ Request for Modification, Replacement or Termination of DBE Project Participation (Attachment E-2) *
- _____ Subcontractor Monthly Utilization Report (Attachment E-3) *
- _____ Schedule of Participation by Contractor & Subcontractor (Attachment E-4) ***
- _____ Workforce Analysis Report (Attachment F-2) *
- _____ Affidavit of Primary Participants Compliance with Section 285.500 RSMO, ET SEQ. Regarding Employee Eligibility Verification (Attachment G-1) ***
- _____ Affidavit of Lower-Tier Participants Compliance with Section 285.500 RSMO, ET SEQ. Regarding Employee Eligibility Verification (Attachment G-2) ***
- _____ Certification of Primary Participants Regarding Debarment, Suspension, and Other Ineligibility and Voluntary Exclusion (Attachment H-1) ***
- _____ Certification of Lower-Tier Participants Regarding Debarment, Suspension, and Other Ineligibility and Voluntary Exclusion (Attachment H-2) ***
- _____ Certification of Primary Participants Regarding Restrictions on Lobbying (Attachment I-1) ***
- _____ Certification of Lower-Tier Participants Regarding Restrictions on Lobbying (Attachment I-2) ***
- _____ Buy America Certification Form (Attachment J) ***
- _____ Sample of Request for Interpretation (RFI) Form (Attachment K) *
- _____ Letter of Intent to Subcontract (DBE Form) (Attachment L) *
- _____ Sample of Subcontractor Affidavit for Final Payment (Attachment M) *
- _____ Project Exemption Certificate (Form 5060) (Attachment N) *
- _____ KCSC Project Safety Requirements (Attachment P) *
- _____ Wage Control Documents *
- _____ KCMO General Conditions (Attachment Q1) *
- _____ KCMO Supplementary Conditions Project # 89022000 (Attachment Q2) *
- _____ "SAMPLE" Kansas City Streetcar Constructors (KCSC) Subcontract Agreement *
- _____ Project Workforce Monthly Report (Attachment R1)*
- _____ Company-Wide Workforce Monthly Report (Attachment R2)*
- _____ Plans – 100% Design Submittal (Volumes 2 & 4) (on KC Planroom) *
- _____ Project Specifications – 100% Design Submittal (on KC Planroom) *

***- Item is for information/sample only and does not need to be returned**

**** - Must be returned, completed with the Pre-Qualification**

***** - Must be returned, completed, with Final Bid Pricing**

[20 Documents]

[1 Document]

[13 Documents]



ATTACHMENT B1

Pre Contract Bidder's Certification

Project Number _____

Project Title _____

STATE OF _____)
) SS
COUNTY OF _____)

Before me, the undersigned authority, personally appeared, who, being by me duly sworn deposed as follows:

I am authorized to make this affidavit on behalf of the named Bidder. I am of sound mind, capable of making this affidavit, and personally acquainted with the facts herein stated:

A. Bidder is current on payment of its Federal and State Income tax withholding and unemployment insurance payments, either in Missouri for companies doing business in Missouri, or in the state in which Bidder has its principal office; and

B. Bidder declares one of the following, regarding all work performed two (2) years immediately preceding the date of the Bid (check one):

Contract by contract listing of all of Bidder's written notices of violations of any Federal or State prevailing wage statute in which prevailing wage penalties were assessed against the Bidder or paid by the Bidder (Complete and attach additional sheets if necessary):

1. _____
2. _____
3. _____

There have been no written notices of violations of any Federal or State prevailing wage statute in which prevailing wage penalties were assessed against the Bidder or paid by the Bidder.

C. Bidder is currently in good standing with the Missouri Secretary of State or Bidder has filed a Registration of Fictitious Name with the Missouri Secretary of State.

(Bidder's Name)

(Date)

Signature of Person Making This Affidavit

In witness whereof, I have hereunto subscribed my name and affixed my official seal this ___ day of _____, 20__.

ATTACHMENT C

ANTI-COLLUSION STATEMENT

STATE OF MISSOURI

CITY/COUNTY OF _____

_____ being first duly sworn, deposes and says that he is

_____ Title of Person Signing

of _____

_____ Name of Bidder

that all statements made and facts set out in the proposal for the above project are true and correct; and the bidder (The person, firm, association, or corporation making said bid) has not, either directly or indirectly, entered into any agreement, participated in any collusion, or otherwise taken any action in restraint of free competitive bidding in connection with said bid or any contract which may result from its acceptance.

Affiant further certifies that bidder is not financially interested in, or financially affiliated with, any other bidder for the above project.

BY _____

BY _____

BY _____

SWORN to before me this _____ day of _____ 20 ____.

_____ Notary Public

My Commission Expires _____

CITY OF FOUNTAINS
HEART OF THE NATION



KANSAS CITY
MISSOURI

PAYMENT BOND

Project Number _____

Project Title _____

KNOW ALL MEN BY THESE PRESENTS: That _____, as PRINCIPAL (CONTRACTOR), and _____, (SURETY), licensed to do business as such in the State of Missouri, hereby bind themselves and their respective heirs, executors, administrators, successors, and assigns unto Kansas City, Missouri, a constitutionally chartered municipal corporation, (OWNER), as obligee, in the penal sum of _____ Dollars (\$_____) for the payment whereof CONTRACTOR and SURETY bind themselves, their heirs, executors, administrators, successors and assigns, jointly and severally, firmly by these presents.

WHEREAS,

CONTRACTOR has entered into a contract with OWNER for _____, which Contract, including any present or future amendment thereto, is incorporated herein by reference and is hereinafter referred to as the Contract.

NOW, THEREFORE, THE CONDITION OF THIS OBLIGATION is such that, if in connection with the Contract, including all duly authorized modifications thereto, prompt payment shall be made to all laborers, subcontractors, teamsters, truck drivers, owners or other suppliers or for equipment employed on the job, and other claimants, for all labor performed in such work whether done for CONTRACTOR, a subcontractor, SURETY, a completion contractor or otherwise (at the full wage rates required by any law of the United States or of the State of Missouri, where applicable), for services furnished and consumed, for repairs on machinery, for equipment, tools, materials, lubricants, oil, gasoline, water, gas, power, light, heat, oil, telephone service, grain, hay, feed, coal, coke, groceries and foodstuffs, either consumed, rented, used or reasonably required for use in connection with the construction of the work or in the performance of the Contract and all insurance premiums, both for compensation and for all other kinds of insurance on the work, for sales taxes and for royalties in connection with, or incidental to, the completion of the Contract, in all instances whether the claim be directly against CONTRACTOR, against SURETY or its completion contractor, through a subcontractor or otherwise, and, further, if CONTRACTOR shall defend, indemnify and hold harmless OWNER from all such claims, demands or suits by any such person or entity, then this obligation shall be void; otherwise, it shall remain in full force and effect.

Any conditions legally required to be included in a Payment Bond on this Contract, including but not limited to those set out in §107.170 RSMo. are included herein by reference.

SURETY agrees that, in the event that CONTRACTOR fails to make payment of the obligations covered by this Bond, it will do so and, further, that within forty-five (45) days of receiving, at the address given below, a claim hereunder stating the amount claimed and the basis for the claim in reasonable detail, it (a) will send an answer to the claimant, with a copy to OWNER stating the amounts that are undisputed and the basis for challenging any amounts that are disputed, and (b) will pay any amounts that are undisputed. The amount of this Bond shall be reduced by and to the extent of any payment or payments made in good faith hereunder.

While this Bond is in force, it may be sued on at the instance of any party to whom any such payment is due, in the name of OWNER to the use for such party. OWNER shall not be liable for the payment of any costs or expenses of any such suit.

No suit shall be commenced or pursued hereunder other than in a state court of competent jurisdiction in Jackson, Clay or Platte County, Missouri, or in the United States District Court for the Western District of Missouri.

WAIVER. That SURETY, for value received, hereby expressly agrees that no change, extension of time, alteration or addition to the terms of the Contract or to the Work to be performed thereunder, shall in any way affect the obligations of this Bond; and it does hereby waive notice of any such change, extension of time, or alteration or addition to the terms of the Contract or the Work to be performed thereunder.

IN WITNESS WHEREOF, the above parties have executed this instrument the _____ day of _____, 200__.

CONTRACTOR

Name, address and facsimile number of Contractor

I hereby certify that I have authority to execute this document on behalf of Contractor.

By: _____
Title: _____

(Attach corporate seal if applicable)

SURETY

Name, address and facsimile number of Surety:

I hereby certify that (1) I have authority to execute this document on behalf of Surety; (2) Surety has an A.M. Best rating of B+, V. or better; (3) Surety is named in the current list of "Companies Holding Certificates of Authority as Acceptable Sureties on Federal Bonds and as Acceptable Reinsuring Companies" as published in Circular 570 (most current revision) by the Financial Management Service, Surety Bond Branch, U.S. Department of the Treasury; and(4) Surety is duly licensed to issue bonds in the State of Missouri and in the jurisdiction in which the Project is located.

By: _____
Title: _____
Date: _____

(Attach seal and Power of Attorney)

CITY OF FOUNTAINS
HEART OF THE NATION



KANSAS CITY
MISSOURI

PERFORMANCE BOND

Project Number _____

Project Title _____

KNOW ALL MEN BY THESE PRESENTS: That _____, as PRINCIPAL (CONTRACTOR), and _____, (SURETY), licensed to do business as such in the State of Missouri, hereby bind themselves and their respective heirs, executors, administrators, successors, and assigns unto Kansas City, Missouri, a constitutionally chartered municipal corporation, (OWNER), as obligee, in the penal sum of _____ Dollars (\$ _____) for the payment whereof CONTRACTOR and SURETY bind themselves, their heirs, executors, administrators, successors and assigns, jointly and severally, firmly by these presents.

WHEREAS,

CONTRACTOR has entered into a Contract with OWNER for _____ which Contract, including any present or future amendment thereto, is incorporated herein by reference and is hereinafter referred to as the Contract.

NOW, THEREFORE, THE CONDITION OF THIS OBLIGATION is such that, if CONTRACTOR shall promptly and faithfully perform said Contract including all duly authorized changes thereto, according to all the terms thereof, including those under which CONTRACTOR agrees to pay legally required wage rates including the prevailing hourly rate of wages in the locality, as determined by the Department of Labor and Industrial Relations or by final judicial determination, for each craft or type of workman required to execute the Contract and, further, shall defend, indemnify, and hold harmless OWNER from all damages, including but not limited to liquidated damages, loss and expense occasioned by any failure whatsoever of said CONTRACTOR and SURETY to fully comply with and carry out each and every requirement of the Contract, then this obligation shall be void; otherwise, it shall remain in full force and effect.

WAIVER. That SURETY, for value received, hereby expressly agrees that no change, extension of time, alteration or addition to the terms of the Contract or to the Work to be performed thereunder, shall in any way affect the obligations of this Bond; and it does hereby waive notice of any such change, extension of time, or alteration or addition to the terms of the Contract or the Work to be performed thereunder.

IN WITNESS WHEREOF, the above parties have executed this instrument the ____ day of _____, 201____.

CONTRACTOR

Name, address and facsimile number of Contractor

I hereby certify that I have authority to execute this document on behalf of Contractor.

By: _____
Title: _____

(Attach corporate seal if applicable)

SURETY

Name, address and facsimile number of Surety:

I hereby certify that (1) I have authority to execute this document on behalf of Surety; (2) Surety has an A.M. Best rating of B+, V, or better; (3) Surety is named in the current list of "Companies Holding Certificates of Authority as Acceptable Reinsuring Companies: as published in Circular 570 (most current revision) by the Financial Management Service, Surety Bond Branch, U.S. Department of the Treasury; and (4) Surety is duly licensed to issue bonds in the State of Missouri and in the jurisdiction in which the Project is located.

By: _____

Title: _____

Date: _____

(Attach seal and Power of Attorney)



CERTIFICATE OF LIABILITY INSURANCE

DATE (MM/DD/YYYY)

THIS CERTIFICATE IS ISSUED AS A MATTER OF INFORMATION ONLY AND CONFERS NO RIGHTS UPON THE CERTIFICATE HOLDER. THIS CERTIFICATE DOES NOT AFFIRMATIVELY OR NEGATIVELY AMEND, EXTEND OR ALTER THE COVERAGE AFFORDED BY THE POLICIES BELOW. THIS CERTIFICATE OF INSURANCE DOES NOT CONSTITUTE A CONTRACT BETWEEN THE ISSUING INSURER(S), AUTHORIZED REPRESENTATIVE OR PRODUCER, AND THE CERTIFICATE HOLDER.

IMPORTANT: If the certificate holder is an ADDITIONAL INSURED, the policy(ies) must be endorsed. If SUBROGATION IS WAIVED, subject to the terms and conditions of the policy, certain policies may require an endorsement. A statement on this certificate does not confer rights to the certificate holder in lieu of such endorsement(s).

PRODUCER AGENT NAME AND ADDRESS	CONTACT NAME: PHONE (A/C, No, Ext): _____ FAX (A/C, No): _____ E-MAIL ADDRESS: _____ <table style="width: 100%; border: none;"> <tr> <td style="text-align: center; border: none;">INSURER(S) AFFORDING COVERAGE</td> <td style="text-align: right; border: none;">NAIC #</td> </tr> <tr> <td style="border: none;">INSURER A : ABC INSURANCE COMPANY</td> <td style="border: none;"></td> </tr> <tr> <td style="border: none;">INSURER B :</td> <td style="border: none;"></td> </tr> <tr> <td style="border: none;">INSURER C :</td> <td style="border: none;"></td> </tr> <tr> <td style="border: none;">INSURER D :</td> <td style="border: none;"></td> </tr> <tr> <td style="border: none;">INSURER E :</td> <td style="border: none;"></td> </tr> <tr> <td style="border: none;">INSURER F :</td> <td style="border: none;"></td> </tr> </table>	INSURER(S) AFFORDING COVERAGE	NAIC #	INSURER A : ABC INSURANCE COMPANY		INSURER B :		INSURER C :		INSURER D :		INSURER E :		INSURER F :	
INSURER(S) AFFORDING COVERAGE	NAIC #														
INSURER A : ABC INSURANCE COMPANY															
INSURER B :															
INSURER C :															
INSURER D :															
INSURER E :															
INSURER F :															
INSURED CONTRACTOR NAME AND ADDRESS															

COVERAGES**CERTIFICATE NUMBER:****REVISION NUMBER:**

THIS IS TO CERTIFY THAT THE POLICIES OF INSURANCE LISTED BELOW HAVE BEEN ISSUED TO THE INSURED NAMED ABOVE FOR THE POLICY PERIOD INDICATED. NOTWITHSTANDING ANY REQUIREMENT, TERM OR CONDITION OF ANY CONTRACT OR OTHER DOCUMENT WITH RESPECT TO WHICH THIS CERTIFICATE MAY BE ISSUED OR MAY PERTAIN, THE INSURANCE AFFORDED BY THE POLICIES DESCRIBED HEREIN IS SUBJECT TO ALL THE TERMS, EXCLUSIONS AND CONDITIONS OF SUCH POLICIES. LIMITS SHOWN MAY HAVE BEEN REDUCED BY PAID CLAIMS.

INSR LTR	TYPE OF INSURANCE	ADDL INSR	SUBR WVD	POLICY NUMBER	POLICY EFF (MM/DD/YYYY)	POLICY EXP (MM/DD/YYYY)	LIMITS	
A	GENERAL LIABILITY <input checked="" type="checkbox"/> COMMERCIAL GENERAL LIABILITY <input type="checkbox"/> CLAIMS-MADE <input checked="" type="checkbox"/> OCCUR GEN'L AGGREGATE LIMIT APPLIES PER: <input type="checkbox"/> POLICY <input checked="" type="checkbox"/> PROJECT <input type="checkbox"/> LOC	Y	Y	POLICY NUMBER	1/1/2011	1/1/2012	EACH OCCURRENCE \$ 1,000,000 DAMAGE TO RENTED PREMISES (Ea occurrence) \$ 50,000 MED EXP (Any one person) \$ 10,000 PERSONAL & ADV INJURY \$ 1,000,000 GENERAL AGGREGATE \$ 2,000,000 PRODUCTS - COMP/OP AGG \$ 2,000,000 \$	
A	AUTOMOBILE LIABILITY <input checked="" type="checkbox"/> ANY AUTO ALL OWNED AUTOS <input checked="" type="checkbox"/> HIRED AUTOS <input type="checkbox"/> SCHEDULED AUTOS NON-OWNED AUTOS	Y	Y	POLICY NUMBER	1/1/2011	1/1/2012	COMBINED SINGLE LIMIT (Ea accident) \$ 1,000,000 BODILY INJURY (Per person) \$ BODILY INJURY (Per accident) \$ PROPERTY DAMAGE (Per accident) \$ \$	
A	<input checked="" type="checkbox"/> UMBRELLA LIAB <input checked="" type="checkbox"/> OCCUR <input type="checkbox"/> EXCESS LIAB <input type="checkbox"/> CLAIMS-MADE DED <input checked="" type="checkbox"/> RETENTION \$ 10,000	Y	Y	POLICY NUMBER	1/1/2011	1/1/2012	EACH OCCURRENCE \$ 2,000,000 AGGREGATE \$ 2,000,000 \$	
A	WORKERS COMPENSATION AND EMPLOYERS' LIABILITY ANY PROPRIETOR/PARTNER/EXECUTIVE OFFICER/MEMBER EXCLUDED? (Mandatory in NH) If yes, describe under DESCRIPTION OF OPERATIONS below	Y/N	N/A	Y	POLICY NUMBER	1/1/2011	1/1/2012	<input checked="" type="checkbox"/> WC STATUTORY LIMITS <input type="checkbox"/> OTHER E.L. EACH ACCIDENT \$ 1,000,000 E.L. DISEASE - EA EMPLOYEE \$ 1,000,000 E.L. DISEASE - POLICY LIMIT \$ 1,000,000
A	Leased/Rented/Equip. Owned Equipment Builders Risk/Installation Floater	N/A	Y	POLICY NUMBER	1/1/2011	1/1/2012	Limit; Deductible Limit; Deductible Limit; Deductible	

DESCRIPTION OF OPERATIONS / LOCATIONS / VEHICLES (Attach ACORD 101, Additional Remarks Schedule, if more space is required)

Project No. _____ [Title]. Certholder (City) and _____ (Design Professional) and any other entities named in 00800 SCs are named as primary, noncontributing Additional Insureds including products and completed operations, excluding workers compensation, employers liability and professional liability. Waiver of subrogation applies as allowed by law. [The policies required above shall contain no exclusions for work expressly within the subcontractors scope of work.]

CERTIFICATE HOLDER**CANCELLATION**

City of Kansas City, Missouri _____ [Department] _____ [Address] Kansas City, MO _____ [Zip]	SHOULD ANY OF THE ABOVE DESCRIBED POLICIES BE CANCELLED BEFORE THE EXPIRATION DATE THEREOF, NOTICE WILL BE DELIVERED IN ACCORDANCE WITH THE POLICY PROVISIONS. AUTHORIZED REPRESENTATIVE
---	---

© 1988-2010 ACORD CORPORATION. All rights reserved.

**KANSAS CITY Missouri
CONTRACTOR UTILIZATION PLAN/REQUEST FOR WAIVER**

Project Number _____ Project Title _____

Prime Contractor _____

STATE OF _____)
) SS
COUNTY OF _____)

I, _____, of lawful age and upon my oath state as follows:

1. This Affidavit is made for the purpose of complying with the provisions of the Disadvantaged Business Enterprise (DBE) submittal requirements on the above project and the DBE Program and is given on behalf of the Bidder/Proposer listed below. It sets out the Bidder/Proposer's commitment to utilize DBE contractors on the project.
2. The project goal for DBE Participation is _____ %. Bidder/Proposer assures that it will utilize a minimum of the following percentages of DBE participation in the above project:

BIDDER/PROPOSER DBE PARTICIPATION COMMITMENT: _____%

3. The following are the DBE subcontractors whose utilization Bidder/Proposer warrants will meet or exceed the above-listed Bidder/Proposer Participation. Bidder/Proposer warrants that it will utilize the DBE subcontractors to provide the goods/services described in the applicable Letter(s) of Intent to Subcontract, (copies of which shall collectively be deemed incorporated herein). ***All firms must currently be certified with the Missouri Regional Certification Committee (MRCC) under 49 CFR Part 26. List additional DBEs, if any, on an additional page and attach to this form.***

- a. Name of DBE Firm _____ % of Work _____
Address _____
Telephone No. _____
Taxpayer ID No. _____
- b. Name of DBE Firm _____ % of Work _____
Address _____
Telephone No. _____
Taxpayer ID No. _____
- c. Name of DBE Firm _____ % of Work _____
Address _____
Telephone No. _____
Taxpayer ID No. _____

TOTAL DBE \$ AMOUNT ON PROJECT: \$ _____

TOTAL DBE % COMMITTED TO PROJECT: _____ %

4. Bidder/Proposer acknowledges that the monetary amount to be paid each listed DBE for their work, and which is approved herein, is an amount corresponding to the percentage of the total contract amount allocable to each listed DBE as calculated in the **Schedule of Participation by Contractor and Subcontractors** form. Bidder/Proposer further acknowledges that this amount may be higher than the subcontract amount listed therein as change orders and/or amendments changing the total contract amount may correspondingly increase the amount of compensation due a DBE for purposes of meeting or exceeding the Bidder/Proposer participation commitment.
5. Bidder/Proposer acknowledges that it is responsible for considering the effect that any change orders and/or amendments changing the total contract amount may have on its ability to meet or exceed the Bidder/Proposer participation. Bidder/Proposer further acknowledges that it is responsible for submitting a **Request for Modification or Substitution** form if it will be unable to meet or exceed the Bidder/Proposer participation set forth herein.
6. If Bidder/Proposer has not achieved the DBE commitment set for this Project, Bidder/Proposer hereby requests a waiver of the DBE commitment that Bidder/Proposer has failed to achieve.
7. Bidder/Proposer will present documentation of its good faith efforts, a narrative summary detailing its efforts and the reasons its efforts were unsuccessful when requested by CITY OF KANSAS CITY MISSOURI.
8. I hereby certify that I am authorized to sign this Affidavit on behalf of the Bidder/Proposer named below and who shall abide by the terms set forth herein:

Bidder/Proposer Primary Contact: _____

Address: _____

Phone Number: _____ Facsimile number: _____

E-mail Address: _____

By _____
(Signature)

Title _____

Date _____
(Attach corporate seal if applicable)

NOTARY:

Subscribed and sworn to before me this _____ day of _____, 20__.

My Commission Expires: _____

Notary Public

(Seal)

**KANSAS CITY MISSOURI
REQUEST FOR MODIFICATION, REPLACEMENT OR TERMINATION
OF DISADVANTAGED BUSINESS ENTERPRISE (DBE)
PROJECT PARTICIPATION**

This form must be submitted to request substitutions for a DBE listed in the Schedule of Participation By Contractor and Subcontractors form submitted as part of Contractor's Bid Documents as amended by any Change Orders or previously approved Requests for Modification/Substitution. This executed document shall be an amendment to the Contractor's DBE utilization plan.

CONTRACTOR _____

ADDRESS _____

PROJECT NUMBER AND NAME _____

1. As the duly authorized representative of the above Contractor, I am authorized to request this substitution or modification on behalf of the Contractor and hereby request that the Kansas City MISSOURI (CITY OF KANSAS CITY MISSOURI) recommend or approve:

_____ SUBSTITUTION OF DBE FIRM

Name of Current DBE Firm To Be Removed _____

Scope of Work _____

Contracted Amount \$ _____ Amount of Work Completed To Date \$ _____

Name of Proposed DBE Firm _____

Scope of Work _____

Amount of Proposed Work \$ _____ Date Scheduled To Begin Work _____

_____ MODIFICATION OF THE AMOUNT OF WORK BY DBE FIRM

Name of DBE Firm _____

Current % of Contract Commitment _____ Changed % of Contract Commitment _____

2. This Substitution/Modification is necessary because (check all applicable)

_____ The DBE Subcontractor failed or refuses to execute a written contract.

_____ The DBE Subcontractor failed or refuses to perform the work of its normal industry standards without good cause and that failure or refusal of the DBE is not a result of bad faith or discriminatory action of the Contractor.

_____ The DBE Subcontractor failed or refuses to comply with reasonable, non-discriminatory bonding requirements.

_____ The DBE Subcontractor has become bankrupt, insolvent, or exhibits credit unworthiness (supporting documentation is attached).

_____ The DBE Subcontractor has committed a material default or breach of its contract.

_____ The DBE Subcontractor has voluntarily withdrawn from the project (DBE's written notice of withdrawal is attached).

_____ The DBE owner has died or has become disabled and is unable to complete its work on this Project.

_____ A Change Order and/or Amendment of the Project was issued that modifies the amount Contractor is to be compensated and correspondingly impacts the amount of compensation due to the DBE Subcontractor.

3. I affirm that written notice has been given to the DBE Subcontractor of Contractor's intent to request a substitution or modification (copy attached) and the DBE Subcontractor has been given five (5) business days to respond to the notice (a copy of DBE firm's response is attached).

EXCEPTION: If required in a particular case as a matter of public necessity (e.g., safety) the response period may be shortened.

4. The following is a narrative summary of Contractor's good faith efforts (as listed in Part A of the City's Bid Documents) exhausted in attempts to substitute the DBE firm named above with other qualified, certified DBE firms for the listed scope of work or any other scope of work on the project. Supporting documentation is attached.

5. Contractor hereby affirms that it has not intentionally attempted to evade the requirements of the Contract or the DBE Program and it is in CITY OF KANSAS CITY MISSOURI's best interest to approve this Request for Substitution or Modification. Additional documentation will be presented when requested by CITY OF KANSAS CITY MISSOURI in order to make its determination.

Submitted By:

Approved By:

Contractor's Authorized Representative
Representative

CITY OF KANSAS CITY MISSOURI's Authorized

Title

Title

Date

Date

**KANSAS CITY MISSOURI
SUBCONTRACTOR MONTHLY UTILIZATION REPORT**

Report Date:	Project Number:	Project Name:	Payment Application No.
Project Address		Contract Award Date:	Contract Start Date:
Prime Contractor Name:		Contact Person/Phone:	Email Address:
Prime Contractor Address:		Total Contract Amount:	Project DBE Goal (%): Contractor DBE Commitment on Project (%):

PAYMENTS TO SUBCONTRACTORS (INCLUDING DBE AND NON-DBE)

	DBE ? Yes / No	Contract		Current Payment Application			Previous Payment Applications			Current + Previous Payment Applications			Actual Payments Received to Date	% of Contract Paid to Date
		Amount	% of Total Contract	Total Amount Billed This Period	Retainage This Period	Scheduled Payment This Period	Total Billed to Date	Retainage to Date	Scheduled Payments to Date	Total Billed to Date	Total Retainage to Date	Total Scheduled Payments to Date		
General Contractor		\$ -	%	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	%
Subcontractor 1		\$ -	%	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	%
Subcontractor 2		\$ -	%	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	%
Subcontractor 3		\$ -	%	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	%
Subcontractor 4		\$ -	%	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	%
Subcontractor 5		\$ -	%	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	%
Subcontractor 6		\$ -	%	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	%
Subcontractor 7		\$ -	%	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	%
Subcontractor 8		\$ -	%	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	%
TOTALS FOR THIS REPORTING PERIOD		\$ -	%	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	%

Report Submitted By: _____

Date Submitted: _____

Report is to be submitted with each pay application

REMINDER: Contractor is responsible for meeting or exceeding the DBE commitment amounts listed on the **Schedule of Participation by Contractor and Subcontractors** form submitted as part of Contractor's Bid Documents and as amended by any previously approved Request for Modification/Substitution. Any Change Orders or amendments modifying the amount Contractor is to be compensated will have correspondingly impacted the amount of compensation due to DBEs for purposes of meeting or exceeding the Bidder/Proposer commitment. Contractor shall consider the effect of a Change Order or amendment and submit a Request for Modification/Substitution form if appropriate.

SCHEDULE OF PARTICIPATION BY CONTRACTOR & SUBCONTRACTORS

Form must be submitted for each prospective offeror and submitted with proposal

PRIME CONTRACTOR				
Name and Address	Telephone No. Fax No.	Type of Work To Be Performed	Value of Work	DBE % Participation
			\$	%
ALL SUBCONTRACTOR(S) (DBE & NON-DBE)				
Name and Address	Telephone No. Fax No.	Type of Work To Be Performed	Value of Work	DBE % Participation
			\$	%
			\$	%
			\$	%
			\$	%
			\$	%

TOTAL VALUE OF WORK \$ _____

TOTAL CONTRACT VALUE OF WORK
(FROM COST/PRICE PROPOSAL – ATTACHMENT D-1) \$ _____

TOTAL DBE PARTICIPATION \$ _____

TOTAL PERCENTAGE OF DBE PARTICIPATION _____%

THE UNDERSIGNED WILL ENTER INTO A FORMAL AGREEMENT WITH THE SUBCONTRACTOR(S) FOR THE WORK LISTED ON THIS SCHEDULE.

Prime Contractor (Type/Print) _____ Date _____

Authorized Signature _____ Title _____

Name (Type/Print) _____ Telephone #/Fax # _____

Report all permanent, temporary, or part-time employees including apprentices and on-the-job trainees.
Enter the appropriate figures on all lines and in all columns. All blank spaces will be considered zero.

Job Categories	Number of Employees (Report employees in only one category)														
	Race/Ethnicity														
	Hispanic or Latino		Not Hispanic or Latino												Total Col A-N
	Male	Female	Male						Female						
White			Black or African American	Native Hawaiian or Other Pacific Islander	Asian	American Indian or Alaska Native	Two or more races	White	Black or African American	Native Hawaiian or Other Pacific Islander	Asian	American Indian or Alaska Native	Two or more races		
A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	
Executive/Senior-Level Officials and Managers															
First/Mid-Level Officials and Managers															
Professionals															
Technicians															
Sales Workers															
Administrative Support Workers															
Craft Workers															
Operatives															
Laborers and Helpers															
Service Workers															
TOTAL															
PREVIOUS YEAR TOTAL															
TYPE OF BUSINESS	<input type="checkbox"/> Manufacturing		<input type="checkbox"/> Wholesale			<input type="checkbox"/> Construction		<input type="checkbox"/> Regular Dealer		<input type="checkbox"/> Selling Agent		<input type="checkbox"/> Service Establishment			<input type="checkbox"/> Other

Signature of Certifying Official _____

Company Name _____

Printed Name and Title _____

Address/City/State/Zip Code _____

Date Submitted _____

Telephone Number/Fax Number _____

**ATTACHMENT G-1
AFFIDAVIT OF PRIMARY PARTICIPANTS
COMPLIANCE WITH SECTION 285.500 RSMO, ET SEQ.
REGARDING EMPLOYEE ELIGIBILITY VERIFICATION**

STATE OF _____

COUNTY OF _____

On this _____ day of _____, 20____, before me appeared _____, personally known by me or otherwise proven to be the person whose name is subscribed on this affidavit and who, being duly sworn, stated as follows: I am the _____ (title) of _____ (business entity) and I am duly authorized, directed or empowered to act with full authority on behalf of the business entity in making this affidavit.

I hereby swear or affirm that the business entity does not knowingly employ any person in connection with the contracted services who does not have the legal right or authorization under federal law to work in the United States as defined in 8 U.S.C. §1324a(h)(3).

I hereby additionally swear or affirm that the business entity is enrolled in an electronic verification of work program operated by the United States Department of Homeland Security (E-Verify) or an equivalent federal work authorization program operated by the United States Department of Homeland Security to verify information of newly hired employees, under the Immigration Reform and Control Act of 1986, and that the business entity will participate in said program with respect to any person hired to perform any work in connection with the contracted services.

I have attached hereto documentation sufficient to establish the business entity's enrollment and participation in the required electronic verification of work program. I shall require that the language of this affidavit be included in the award documents for all sub-contracts exceeding \$5,000.00 at all tiers and that all subcontractors at all tiers shall affirm and provide documentation accordingly.

Affiant's signature

Subscribed and sworn to before me this _____ day of _____, 20____

Notary Public

My Commission expires:

NOTE: An example of acceptable documentation is the E-Verify Memorandum of Understanding (MOU) – a valid, completed copy of the first page identifying the business entity and a valid copy of the signature page completed and signed by the business entity, the Social Security Administration and the Department of Homeland Security.

**ATTACHMENT G-2
AFFIDAVIT OF LOWER-TIER PARTICIPANTS
COMPLIANCE WITH SECTION 285.500 RSMO, ET SEQ.
REGARDING EMPLOYEE ELIGIBILITY VERIFICATION**

STATE OF _____

COUNTY OF _____

On this _____ day of _____, 20____, before me appeared _____, personally known by me or otherwise proven to be the person whose name is subscribed on this affidavit and who, being duly sworn, stated as follows: I am the _____ (title) of _____ (business entity) and I am duly authorized, directed or empowered to act with full authority on behalf of the business entity in making this affidavit.

I hereby swear or affirm that the business entity does not knowingly employ any person in connection with the contracted services who does not have the legal right or authorization under federal law to work in the United States as defined in 8 U.S.C. §1324a(h)(3).

I hereby additionally swear or affirm that the business entity is enrolled in an electronic verification of work program operated by the United States Department of Homeland Security (E-Verify) or an equivalent federal work authorization program operated by the United States Department of Homeland Security to verify information of newly hired employees, under the Immigration Reform and Control Act of 1986, and that the business entity will participate in said program with respect to any person hired to perform any work in connection with the contracted services.

I have attached hereto documentation sufficient to establish the business entity's enrollment and participation in the required electronic verification of work program. I shall require that the language of this affidavit be included in the award documents for all sub-contracts exceeding \$5,000.00 at all tiers and that all subcontractors at all tiers shall affirm and provide documentation accordingly.

Affiant's signature

Subscribed and sworn to before me this _____ day of _____, 20____

Notary Public

My Commission expires:

NOTE: An example of acceptable documentation is the E-Verify Memorandum of Understanding (MOU) – a valid, completed copy of the first page identifying the business entity and a valid copy of the signature page completed and signed by the business entity, the Social Security Administration and the Department of Homeland Security.

**ATTACHMENT H-1
CERTIFICATION OF PRIMARY PARTICIPANT
REGARDING DEBARMENT, SUSPENSION, AND OTHER
RESPONSIBILITY MATTERS**

The Primary Participant (applicant for an FTA grant or cooperative agreement, or potential Contractor for a major third party contract), _____ certifies to the best of its knowledge and belief, that it and its principals:

1. Are not presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal department or agency;
2. Have not within a three-year period preceding this bid, been convicted of or had a civil judgment rendered against them for commission of fraud or a criminal offense in connection with obtaining, attempting to obtain, or performing a public (Federal, State or local) transaction or contract under a public transaction; violation of Federal or State antitrust statutes or commission of embezzlement, theft, forgery, bribery, falsification or destruction of records, making false statements, or receiving stolen property;
3. Are not presently indicted for or otherwise criminally or civilly charged by a governmental entity (Federal, State or local) with commission of any of the offenses enumerated in paragraph (2) of this certification; and
4. Have not within a three-year period preceding this application/bid had one or more public transactions (Federal, State or local) terminated for cause or default.

If the primary participant (applicant for FTA grant, or cooperative agreement, or potential third party Contractor) is unable to certify to any of the statements in this certification, the participant shall attach an explanation to this certification.

THE PRIMARY PARTICIPANT (APPLICANT FOR AN FTA GRANT OR COOPERATIVE AGREEMENT, OR POTENTIAL CONTRACTOR FOR A MAJOR THIRD PARTY CONTRACT), _____ CERTIFIES OR AFFIRMS THE TRUTHFULNESS AND ACCURACY OF THE CONTENTS OF THE STATEMENTS SUBMITTED ON OR WITH THIS CERTIFICATION AND UNDERSTANDS THAT THE PROVISIONS OF 31 U.S.C., SECTIONS 3801 *ET SEQ.* ARE APPLICABLE THERETO.

Signature and Title of Authorized Official

Date

ATTACHMENT H-2
CERTIFICATION OF LOWER-TIER PARTICIPANTS REGARDING
DEBARMENT, SUSPENSION, AND OTHER INELIGIBILITY
AND VOLUNTARY EXCLUSION

The Lower Tier Participant (potential sub-grantee or sub-recipient under an FTA project, potential third party Contractor, or potential subcontractor under a major third party contract) _____, certifies, by submission of this bid, that neither it nor its principals are presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from participation in this transaction by any Federal department or agency.

If the Lower Tier Participant (potential sub-grantee or sub-recipient under an FTA project, potential third party Contractor, or potential subcontractor under a major third party contract) is unable to certify to any of the statements in this certification, such participant shall attach an explanation to this bid.

THE LOWER-TIER PARTICIPANT (POTENTIAL SUB-GRANTEE OR SUB-RECIPIENT UNDER AN FTA PROJECT, POTENTIAL THIRD PARTY CONTRACTOR, OR POTENTIAL SUBCONTRACTOR UNDER A MAJOR THIRD PARTY CONTRACT), _____, CERTIFIES OR AFFIRMS THE TRUTHFULNESS AND ACCURACY OF THE CONTENTS OF THE STATEMENTS SUBMITTED ON OR WITH THIS CERTIFICATION AND UNDERSTANDS THAT THE PROVISIONS OF 31 U.S.C., SECTIONS 3801 *ET SEQ.* ARE APPLICABLE THERETO.

Signature and Title of Authorized Official

Date

ATTACHMENT I-1
CERTIFICATION OF PRIMARY PARTICIPANTS
REGARDING RESTRICTIONS ON LOBBYING

I, _____ (Name and Title of Grantee Official or Potential Contractor for a Major Third Party Contract), hereby certify on behalf of _____
_____ (Name of Grantee or Potential Contractor) that:

1. No Federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.
2. If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form LLL, "Disclosure Form to Report Lobbying," in accordance with its instructions.
3. The undersigned shall require that the language of this certification be included in the award documents for all sub-awards at all tiers (including subcontracts, sub-grants, and contracts under grants, loans, and cooperative agreements) and that all sub-recipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance is placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by Section 1352, Title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than \$10,000 and not more than \$100,000 for each such failure.

Executed this _____ day of _____ 20_____

By _____
Signature of Authorized Official

Title of Authorized Official

ATTACHMENT I-2
CERTIFICATION OF LOWER-TIER PARTICIPANTS
REGARDING RESTRICTIONS ON LOBBYING

I, _____ (Name and Title of Grantee Official or Potential Subcontractor Under a Major Third Party Contract), hereby certify on behalf of _____ (Name of Grantee or Potential Subcontractor) that:

1. No Federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.
2. If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form LLL, "Disclosure Form to Report Lobbying," in accordance with its instructions.
3. The undersigned shall require that the language of this certification be included in the award documents for all sub-awards at all tiers (including subcontracts, sub-grants, and contracts under grants, loans, and cooperative agreements) and that all sub-recipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance is placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by Section 1352, Title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than \$10,000 and not more than \$100,000 for each such failure.

Executed this _____ day of _____, 20____.

By _____
Signature of Authorized Official

Title of Authorized Official

ATTACHMENT J
BUY AMERICA CERTIFICATION FORM
For Buses, Other Rolling Stock and Associated Equipment

Certificate of Compliance with Buy America Rolling Stock Requirements

The bidder or offeror hereby certifies that it will comply with the requirements of 49 U.S.C. 5323(j) and the applicable regulations of 49 CFR 661.11.

Date: _____

Signature: _____

Company: _____

Name: _____

Title: _____

Certificate of Non-Compliance with Buy America Rolling Stock Requirements

The bidder or offeror hereby certifies that it cannot comply with the requirements of 49 U.S.C. Section 5323(j), but may qualify for an exception to the requirements consistent with 49 U.S.C. 5323(j)(2)(C) and the applicable regulations in 49 CFR 661.7.

Date: _____

Signature: _____

Company: _____

Name: _____

Title: _____

**ATTACHMENT J
BUY AMERICA CERTIFICATION FORM**

**For Steel or Manufactured Products
Other Than Rolling Stock**

Certificate of Compliance with Buy America Requirements

The bidder or offeror hereby certifies that it will comply with the requirements of 49 U.S.C. 5323(j)(1), and the applicable regulations in 49 CFR part 661.

Date: _____

Signature: _____

Company: _____

Name: _____

Title: _____

Certificate of Non-Compliance with Buy America Requirements

The bidder or offeror hereby certifies that it cannot meet the requirements of 49 U.S.C. 5323(j), but it may qualify for an exception to the requirements pursuant to 49 U.S.C. 5323(j)(2) as amended, and the applicable regulations in 49 CFR 661.7.

Date: _____

Signature: _____

Company: _____

Name: _____

Title: _____



ATTACHMENT K

REQUEST FOR INTERPRETATION

Project Number _____

Project Title _____

Contractor _____

RFI Number _____ Date _____

From: _____

To: _____

Re: _____

Spec. Sec. Ref:

Paragraph:

Drawing Ref:

Detail:

Signed: _____

Response: _____

Attachments

Response From:

To:

Date Transmitted: _____ Date Rec'd: _____

Signed: _____

Design Professional

Signed: _____

Owner's Representative

- Distribution:
- Owner
 - Contractor
 - Construction Manager
 - Design Professional
 - Consultant _____
 - Other _____

ATTACHMENT L

KANSAS CITY Missouri
LETTER OF INTENT TO SUBCONTRACT
(To be Completed for Each DBE Subcontractor on Project)

Project Number _____

Project Title _____

_____ (“Prime Contractor”) agrees to enter into a contractual agreement with _____ (“DBE Subcontractor”), who will provide the following goods/services in connection with the above-referenced contract:

(Insert a brief narrative describing the goods/services to be provided. Broad categorizations (e.g., “electrical,” “plumbing,” etc.) or the listing of the NAICS Codes in which DBE Subcontractor is certified are insufficient and may result in this Letter of Intent to Subcontract not being accepted.)

for an estimated amount of \$ _____ or _____% of the total estimated contract value.

DBE Subcontractor is currently certified with the Missouri Regional Certification Committee (MRCC) to perform in the capacities indicated herein. Prime Contractor agrees to utilize DBE Subcontractor in the capacities indicated herein, and DBE Subcontractor agrees to work on the above-referenced contract in the capacities indicated herein, contingent upon award of the contract to Prime Contractor.

Signature: Prime Contractor

Signature: DBE Subcontractor

Print Name

Print Name

Title

Date

Title

Date

CITY OF FOUNTAINS
HEART OF THE NATION



KANSAS CITY
MISSOURI

SUBCONTRACTOR AFFIDAVIT FOR FINAL PAYMENT

Project Number _____

Project Title _____

STATE OF MISSOURI)

) ss:

COUNTY OF _____)

After being duly sworn the person whose name and signature appears below hereby states under penalty of perjury that:

1. I am the duly authorized officer of the business indicated below (hereinafter Subcontractor) and I make this affidavit on behalf of Subcontractor in accordance with the requirements set forth in Section 290.290, RSMo. Subcontractor has completed all of the Work required under the terms and conditions of a subcontract as follows:

Subcontract with: _____, Contractor

Work Performed: _____

Total Dollar Amount of Subcontract and all Change Orders: \$ _____

City Certified MBE WBE DBE NA

List certifications: _____

2. Subcontractor fully complied with the provisions and requirements of the Missouri Prevailing Wage Law set forth in Sections 290.210, RSMo through 290.340, RSMo.

Business Entity Type:

- Missouri Corporation
- Foreign Corporation
- Fictitious Name Corporation
- Sole Proprietor
- Limited Liability Company
- Partnership
- Joint Venture
- Other (Specify)

Subcontractor's Legal Name and Address

Phone No. _____

Fax: _____

E:mail: _____

Federal ID No. _____

I hereby certify that I have the authority to execute this affidavit on behalf of Subcontractor.

By: _____

(Signature)

(Print Name)

(Title)

(Date)

NOTARY

Subscribed and sworn to before me this _____ day of _____, 20_____.

My Commission Expires: _____

By _____

Print Name

Title

State of Missouri

EXEMPTION FROM MISSOURI SALES AND USE TAX ON PURCHASES

Issued to:

CITY OF KANSAS CITY
414 E 12TH ST 3RD FLOOR
KANSAS CITY MO 64106

Missouri Tax ID
Number: 12490466

Effective Date:
07/11/2002

Your application for sales/use tax exempt status has been approved pursuant to Section 144.030.1, RSMo. This letter is issued as documentation of your exempt status.

Purchases by your Agency are not subject to sales or use tax if within the conduct of your Agency's exempt functions and activities. When purchasing with this exemption, furnish all sellers or vendors a copy of this letter. This exemption may not be used by individuals making personal purchases.

A contractor may purchase and pay for construction materials exempt from sales tax when fulfilling a contract with your Agency only if your Agency issues a project exemption certificate and the contractor makes purchases in compliance with the provisions of Section 144.062, RSMo.

Sales by your Agency are subject to all applicable state and local sales taxes. If you engage in the business of selling tangible personal property or taxable services at retail, you must obtain a Missouri Retail Sales Tax License and collect and remit sales tax.

This is a continuing exemption subject to legislative changes and review by the Director of Revenue. If your Agency ceases to qualify as an exempt entity, this exemption will cease to be valid. This exemption is not assignable or transferable. It is an exemption from sales and use taxes only and is not an exemption from real or personal property tax.

Any alteration to this exemption letter renders it invalid.

If you have any questions regarding the use of this letter, please contact the Division of Taxation and Collection, P.O. Box 3300, Jefferson City, MO 65105-3300, phone 573-751-2836.



MISSOURI DEPARTMENT OF REVENUE
 CUSTOMER SERVICES DIVISION
PROJECT EXEMPTION CERTIFICATE

FORM
5060
 (REV. 1-2008)

**TO BE GIVEN TO
 YOUR CONTRACTOR**

NAME OF EXEMPT ENTITY ISSUING THE CERTIFICATE		MISSOURI TAX EXEMPTION NUMBER	
City of KCMO		12490466	
ADDRESS	CITY	STATE	ZIP
414 E. 12th Street	Kansas City	MO	64106
BEGIN DATE FOR PROJECT	PROJECTED COMPLETION DATE	PROJECT NUMBER	
October 28, 2013	May 31, 2015	89022000	
DESCRIPTION OF PROJECT			
Kansas City Streetcar CM@ RISK			
PROJECT LOCATION		EXPIRATION DATE	
City of KCMO		May 31, 2015	
THIS EXEMPTION DOES NOT APPLY TO THE PURCHASE OR RENTAL OF MACHINERY, EQUIPMENT, OR TOOLS BY THE CONTRACTOR OR SUB-CONTRACTOR.			
Give a signed copy of this certificate, along with a copy of your Missouri Sales/Use Tax Exemption Letter to each contractor and/or subcontractor who will be purchasing tangible personal property for use in this project. It is your responsibility to ensure the validity of the certificate. You must issue a new certificate if any of the information changes.			
EXEMPT ENTITY'S AUTHORIZED SIGNATURE		DATE	
<i>Jo Lupari</i>		11/7/13	
The Missouri exempt entity named above hereby authorizes the purchase, without sales tax, of tangible personal property to be incorporated or consumed in the construction project identified herein and no other, pursuant to Section 144.062, RSMo. I also declare under penalties of perjury that I employ no illegal or unauthorized aliens as defined under federal law and that I am not eligible for any tax exemption, credit or abatement if I employ such aliens.			
NAME OF PURCHASING CONTRACTOR			
KC Streetcar Constructors			
ADDRESS	CITY	STATE	ZIP
600 S. Riverside Road	St. Joseph	MO	64507
Contractors present this to your supplier in order to purchase the necessary materials tax exempt.			
NOTE: COMPLETE AND SIGN BOTTOM PORTION IF EXTENDING CERTIFICATE TO YOUR SUBCONTRACTOR.			
NAME OF PURCHASING SUBCONTRACTOR			
ADDRESS	CITY	STATE	ZIP
SIGNATURE OF CONTRACTOR		DATE	



Kansas City Streetcar Project Safety Requirements

	Project: _____	Date: _____
	Contractor: _____	Trade(s) _____
	Attendees: _____	Signature: _____
	_____	_____
	_____	_____
	_____	_____
	All contractors are responsible and accountable for communicating the requirements of this meeting, insurance requirements and safety requirements to their lower tiered subcontractors.	
	<p>All contractors and lower-tiered subcontractors shall submit directly to the project safety manager the following safety information, prior to the start of work.</p> <ol style="list-style-type: none"> 1. Corporate Safety Program For Approval by KCSCJV 2. Hazard Communication Program and Jobsite Specific MSDS's. 3. Site Specific Fall Protection and Rescue Program. 4. Name and email address of onsite & offsite manager responsible for implementation and enforcement of this safety program. 5. Name of the designated safety coordinator. 6. Name & qualifications of the competent person(s). 7. OSHA 10 and/or 30 hour certified workers. 8. Emergency contacts and phone numbers. 9. Certified First Aid/CPR Personnel. 10. The process for safety preplanning all work task (Daily Pre-task). 11. Cranes: Annual Inspection Certification and operator's qualifications. 	
	All contractors and lower-tiered subcontractors will designate a "project safety coordinator" for the duration of their work being performed on the project. If a subcontractor has less than 5 workers, then the prime contractors "project safety coordinator" can be substituted.	
	<p>All contractors and lower-tier subcontractors shall conduct/attend the following meetings, training sessions, and/or safety meetings:</p> <ol style="list-style-type: none"> 1. Attend Superintendents Weekly Coordination Meetings. 2. Attend Weekly Safety/Training Meetings - safety coordinators. 3. Conduct and document Weekly Toolbox Safety Meetings. 4. Conduct and document Daily Safety Pre-Task Planning Meetings. 5. Conduct and document Safety Pre-Planning Meetings. 6. Attend Incident Review Meetings. 7. Attend monthly All Hands Safety Meetings. 	
	<p>All contractors and lower-tier subcontractors project safety coordinator shall collect and provide to the project safety manager, the following reports:</p> <ol style="list-style-type: none"> 1. Weekly Toolbox Safety Talks - weekly. 2. Incident/Near-Miss investigation reports - 24 hours. 3. Daily Safety Pre-Planning Meetings Reports - Daily or Weekly. 4. Industrial Hygiene monitoring results (i.e. Noise, Air Quality, etc.) - Upon Receipt. 5. Daily Crane Inspection Reports - Weekly. 6. Insurance, safety consultant, and company safety reports - Upon Request. 	



	Project: _____	Date: _____		
	Contractor: _____	Trade(s) _____		
	<p>Safety enforcement on the project will consist of</p> <ol style="list-style-type: none"> 1. Workers: "ZERO TOLERANCE - Removal of the worker(s)" for fall violations, serious violations, or as warranted. 2. Workers: Oral warnings, written warnings, 3 day suspensions, removal from the jobsite. 3. All contractors and subcontractors: additional training (OSHA 10 hour, OSHA 30 hour or other as appropriate, or mandatory purchase of additional safety equipment). 4. Contractor and their subcontractors responsible for any OSHA multi-employer citations and fines will be responsible for paying all fines and cost associated with the citation and fine. 			
	<p>All contractors and lower-tier subcontractors are responsible for enforcing the following safety programs, policies and procedures on this project:</p> <ol style="list-style-type: none"> 1. Federal OSHA, and local regulations. 2. Fall protection: 100% 6-foot fall protection policy for all trades. 3. Personal Protective Equipment: 100% hard-hat, eye protection, steel toe boots, clothing, and high visibility vest policy. 4. Lifting/Material Handling (maximum lift: 50 lbs, proper lifting techniques, mechanical equipment) 5. Housekeeping - Daily clean up. 6. Daily inspections by the competent person: fall protection, trenching, scaffolding, cranes, etc. 7. Conducting pre-planning meetings for all hazardous operations. 8. Conducting daily safety pre-task planning meetings. 9. Conducting weekly toolbox safety meetings. 10. Reporting all accidents and incidences within one hour. 			
	OSHA Inspection procedures			
	<p>Please check if operations include any of the following exposures:</p> <table style="width: 100%; border: none;"> <tr> <td style="width: 50%; vertical-align: top;"> <input type="checkbox"/> Lifting/Material Handling <input type="checkbox"/> Trenching <input type="checkbox"/> Demolition <input type="checkbox"/> Electrical <input type="checkbox"/> Masonry <input type="checkbox"/> Painting Sealing <input type="checkbox"/> Falls <input type="checkbox"/> Aerial Lifts <input type="checkbox"/> Dust/Vapors <input type="checkbox"/> Equipment/Vehicles <input type="checkbox"/> Confine Spaces <input type="checkbox"/> Other: _____ _____ _____ _____ _____ </td> <td style="width: 50%; vertical-align: top;"> <input type="checkbox"/> Pre-cast Panels <input type="checkbox"/> Scaffolding <input type="checkbox"/> Concrete Noise <input type="checkbox"/> Blasting <input type="checkbox"/> Steel Erection <input type="checkbox"/> Overhead/Underground Utilities <input type="checkbox"/> Visitors <input type="checkbox"/> Cranes <input type="checkbox"/> Welding/Torching <input type="checkbox"/> Traffic Control <input type="checkbox"/> Storage Tanks <input type="checkbox"/> Other: _____ </td> </tr> </table>		<input type="checkbox"/> Lifting/Material Handling <input type="checkbox"/> Trenching <input type="checkbox"/> Demolition <input type="checkbox"/> Electrical <input type="checkbox"/> Masonry <input type="checkbox"/> Painting Sealing <input type="checkbox"/> Falls <input type="checkbox"/> Aerial Lifts <input type="checkbox"/> Dust/Vapors <input type="checkbox"/> Equipment/Vehicles <input type="checkbox"/> Confine Spaces <input type="checkbox"/> Other: _____ _____ _____ _____ _____	<input type="checkbox"/> Pre-cast Panels <input type="checkbox"/> Scaffolding <input type="checkbox"/> Concrete Noise <input type="checkbox"/> Blasting <input type="checkbox"/> Steel Erection <input type="checkbox"/> Overhead/Underground Utilities <input type="checkbox"/> Visitors <input type="checkbox"/> Cranes <input type="checkbox"/> Welding/Torching <input type="checkbox"/> Traffic Control <input type="checkbox"/> Storage Tanks <input type="checkbox"/> Other: _____
<input type="checkbox"/> Lifting/Material Handling <input type="checkbox"/> Trenching <input type="checkbox"/> Demolition <input type="checkbox"/> Electrical <input type="checkbox"/> Masonry <input type="checkbox"/> Painting Sealing <input type="checkbox"/> Falls <input type="checkbox"/> Aerial Lifts <input type="checkbox"/> Dust/Vapors <input type="checkbox"/> Equipment/Vehicles <input type="checkbox"/> Confine Spaces <input type="checkbox"/> Other: _____ _____ _____ _____ _____	<input type="checkbox"/> Pre-cast Panels <input type="checkbox"/> Scaffolding <input type="checkbox"/> Concrete Noise <input type="checkbox"/> Blasting <input type="checkbox"/> Steel Erection <input type="checkbox"/> Overhead/Underground Utilities <input type="checkbox"/> Visitors <input type="checkbox"/> Cranes <input type="checkbox"/> Welding/Torching <input type="checkbox"/> Traffic Control <input type="checkbox"/> Storage Tanks <input type="checkbox"/> Other: _____			



GENERAL CONDITIONS TABLE OF CONTENTS

ARTICLE 1 DEFINITIONS AND TERMINOLOGY

- 1.01 Defined Terms
- 1.02 Terminology

ARTICLE 2 PRELIMINARY MATTERS

- 2.01 Delivery of Bonds
- 2.02 Evidence of Insurance
- 2.03 Copies of Documents
- 2.04 Commencement of Contract Times; Notice to Proceed
- 2.05 Starting the Work
- 2.06 Before Starting Construction
- 2.07 Initially Acceptable Schedules

ARTICLE 3 CONTRACT DOCUMENTS: INTENT, AMENDING, REUSE

- 3.01 Intent
- 3.02 Reference to Standards and Specifications of Technical Societies
- 3.03 Reporting and Resolving Discrepancies
- 3.04 Amending and Supplementing Contract Documents
- 3.05 Reuse of Documents

ARTICLE 4 AVAILABILITY OF LANDS; SUBSURFACE AND PHYSICAL CONDITIONS; REFERENCE POINTS

- 4.01 Availability of Lands
- 4.02 Subsurface and Physical Conditions
- 4.03 Differing Subsurface or Physical Conditions
- 4.04. Physical Conditions - Underground Facilities
- 4.05 Reference Points
- 4.06 Asbestos, Lead-Based Paint, PCBs, Petroleum, Hazardous Waste or Radioactive Material

ARTICLE 5 BONDS AND INSURANCE

- 5.01 Performance, Payment and Other Bonds
- 5.02 Licensed Sureties and Insurers
- 5.03 Certificates of Insurance
- 5.04 CONTRACTOR's Liability Insurance
- 5.05 CITY's Liability Insurance
- 5.06 Property Insurance
- 5.07 Waiver of Rights
- 5.08 Receipt and Application of Insurance Proceeds
- 5.09 Partial Utilization - Property Insurance

ARTICLE 6 CONTRACTOR'S RESPONSIBILITIES

- 6.01 Indemnification

- 6.02 Supervision and Superintendence
- 6.03 Services, Working Hours, Labor, Materials and Equipment
- 6.04 Progress Schedule
- 6.05 Recovery Schedules
- 6.06 Substitutes and "Or-Equal" Items
- 6.07 Concerning Subcontractors, Suppliers and Others
- 6.08 Patent Fees and Royalties
- 6.09 Permits
- 6.10 Laws or Regulations
- 6.11 Taxes
- 6.12 Use of Site and Other Areas
- 6.13 Record Documents
- 6.14 Safety and Protection
- 6.15 Safety Representative
- 6.16 Hazard Communication Programs
- 6.17 Emergencies
- 6.18 Shop Drawings and Samples
- 6.19 Continuing the Work
- 6.20 CONTRACTOR's General Warranty and Guarantee

ARTICLE 7 OTHER WORK

- 7.01 Related Work at Site
- 7.02 Coordination

ARTICLE 8 CITY's RESPONSIBILITIES

- 8.01 Communications to CONTRACTOR
- 8.02 Replacement of DESIGN PROFESSIONAL
- 8.03 Furnish Data and Prompt Payment
- 8.04 Lands and Easements; Reports and Tests
- 8.05 Insurance
- 8.06 Change Orders
- 8.07 Inspections, Tests and Approvals
- 8.08 Limitations on CITY's Responsibilities
- 8.09 Undisclosed Hazardous Environmental Condition
- 8.10 Evidence of Financial Arrangements
- 8.11 CITY's Representative
- 8.12 Visits to Site

ARTICLE 9 DESIGN PROFESSIONAL's STATUS DURING CONSTRUCTION

- 9.01 General Scope of DESIGN PROFESSIONAL's Duties
- 9.02 Resident Project Representative
- 9.03 Clarifications and Interpretations
- 9.04 Rejecting Defective Work
- 9.05 Shop Drawings, Change Orders and Payments
- 9.06 Determinations for Unit Prices
- 9.07 Decisions on Requirements of Contract Documents and Acceptability of Work
- 9.08 Limitations on DESIGN PROFESSIONAL's Authority and Responsibilities

ARTICLE 10 CHANGES IN THE WORK

- 10.01 Authorized Changes in the Work
- 10.02 Unauthorized Changes in the Work
- 10.03 Execution of Change Orders
- 10.04 Notification to Surety

ARTICLE 11 CHANGE OF CONTRACT PRICE

- 11.01 Change of Contract Price
- 11.02 Cost of the Work
- 11.03 Cash Allowances
- 11.04 Unit Price Work
- 11.05 Dispute Resolution

ARTICLE 12 CONTRACT TIMES

- 12.01 Time of the Essence
- 12.02 Change of Contract Times
- 12.03 Proof Required To Justify An Extension of Time For Excusable and Compensable Delays
- 12.04 Delays Within CONTRACTOR's Control
- 12.05 Delays Beyond the CITY's and CONTRACTOR's Control
- 12.06 Delay Damages
- 12.07 Dispute Resolution

ARTICLE 13 TESTS AND INSPECTIONS; CORRECTION, REMOVAL OR ACCEPTANCE OF DEFECTIVE WORK

- 13.01 Access to Work
- 13.02 Tests and Inspections
- 13.03 Notice of Defects
- 13.04 Uncovering Work
- 13.05 CITY May Stop the Work
- 13.06 Correction or Removal of Defective Work
- 13.07 Correction Period
- 13.08 Acceptance of Defective Work
- 13.09 CITY May Correct Defective Work

ARTICLE 14 PAYMENTS TO CONTRACTOR AND COMPLETION

- 14.01 Schedule of Values
- 14.02 Application for Progress Payments
- 14.03 Contractor's Warranty of Title
- 14.04 Substantial Completion
- 14.05 Partial Utilization
- 14.06 Final Inspection
- 14.07 Final Payment
- 14.08 Final Completion Delayed
- 14.09 Waiver of Claims
- 14.10 Completion of Work by City

ARTICLE 15 SUSPENSION OF WORK AND TERMINATION

- 15.01 CITY May Suspend Work
- 15.02 CITY May Terminate for Default
- 15.03 CITY May Terminate for Convenience

ARTICLE 16 CLAIMS AND DISPUTES

- 16.01 Definition
- 16.02 Written Notice and Burden of Proof
- 16.03 Time Limits on Claims
- 16.04 Continuing Contract Performance
- 16.05 Injury or Damage to Person or Property
- 16.06 Initial Resolution of Claims and Disputes

16.07 Final Resolution of Claims and Disputes

ARTICLE 17 MISCELLANEOUS

17.01 Giving Notice

17.02 Computation of Times

17.03 Cumulative Remedies

17.04 Survival of Obligations

17.05 Controlling Law

ARTICLE 1 DEFINITIONS AND TERMINOLOGY

1.01 Defined Terms

A. Wherever used in these General Conditions or in the other Contract Documents, the following terms have the meanings indicated which are applicable to both the singular and plural thereof:

1. Addenda - Written or graphic instruments issued prior to the opening of Bids that clarify, correct or change the Bidding Requirements or the Contract Documents.

2. Agreement—The written Contract between CITY and CONTRACTOR governing the Work to be performed; other Contract Documents are attached to the Agreement and made a part thereof as provided therein.

3. Application for Payment—The form accepted by CITY's Representative which is to be used by CONTRACTOR in requesting progress or final payments and which is to be accompanied by such supporting documentation as is required by the Contract Documents.

4. Asbestos - Any material that contains more than one percent (1%) Asbestos and is friable or is releasing Asbestos fibers into the air above current action levels established by the United States Occupational Safety and Health Administration.

5. Bid- The offer or proposal of the Bidder submitted on the Bid Form/Contract setting forth the prices for the Work to be performed. A Bidder's Bid becomes a Contract with CITY if the CITY executes the Bid Form/Contract submitted by Bidder. If the CITY executes the Bid Form/Contract submitted by Bidder, the term "Bidder" shall mean CONTRACTOR.

6. Bidder- One who submits a Bid directly to CITY, as distinct from a sub-bidder who submits a bid to a Bidder. If the CITY executes the Bid Form/Contract submitted by Bidder, the term "Bidder" shall mean CONTRACTOR in both the Bidding Documents and Contract Documents unless the context clearly indicates otherwise.

7. Bidding Documents- The advertisement or Invitation to Bid, Instructions to Bidders, the Bid Form/Contract, and the proposed Contract Documents (including all Addenda issued prior to receipt of Bids).

8. Bidding Requirements- The advertisement or invitation to bid, Instructions to Bidders, Bid security, and the Bid Form/Contract with any supplements.

9. Bonds- Payment Bond and Performance and Maintenance Bond and other instruments of security.

10. Calendar Day- Any day shown on the calendar, including Saturdays, Sundays, and holidays.

11. Change Order- A written document issued by CITY that authorizes an addition, deletion or revision in the Work, or an adjustment in the Contract Price or the Contract Times, issued on or after the Effective Date of the Contract.

12. CITY/OWNER- Kansas City, Missouri, a constitutionally chartered municipal corporation, with which CONTRACTOR has entered into the Contract and for whom the Work is to be provided.

13. CITY's Representative- Person or agency designated to act for the Director as provided in these Contract Documents.

14. Consultant- Person, firm or corporation having a contract with CITY or DESIGN PROFESSIONAL to furnish services as an independent professional associate or Consultant with respect to the Project and who's identified as such in the Supplementary Conditions.

The Consultant(s) is identified and their seals affixed on the Certification Page(s). The certifications describe the respective responsibilities for the Drawings and Specifications prepared by the Consultant(s) and are incorporated into this Contract.

15. Contract- The entire and integrated written agreement between CITY and CONTRACTOR concerning the Work that incorporates all Contract Documents. The Bid Form/Contract submitted by Bidder is the Contract between CITY and CONTRACTOR upon execution by CITY. The Contract supersedes prior negotiations, representations, or agreements, whether written or oral.

16. Contract Documents- The Contract Documents establish the rights and obligations of the parties and include the Contract, Addenda (which pertain to the Contract Documents), CONTRACTOR's Bid Form/Contract (including documentation accompanying the Bid and any post Bid documentation submitted prior to the Notice of Intent to Contract), the HRD Construction Project Instructions, the Contractor's Utilization Plan/Request for Waiver, the Notice to Proceed, the Bonds, these General Conditions, the Supplementary Conditions, the Specifications and the Drawings as the same are more specifically identified in the Project Manual and the certification page(s) of the DESIGN PROFESSIONAL and Consultant(s), together with approved project baseline schedule and amendments thereto and all Written Amendments, Change Orders, Work Change Directives, and DESIGN PROFESSIONAL's written interpretations and clarifications issued on or after the Effective Date of the Contract, and approved Shop Drawings. Reports and drawings of subsurface and physical conditions are not Contract Documents. Only printed or hard copies of the items listed in this Paragraph are Contract Documents. Files in electronic media format of text, data, graphics, and the like that may be furnished by CITY to CONTRACTOR are not Contract Documents, except project schedules submitted by CONTRACTOR and approved by CITY.

17. Contract Price- The money payable by CITY to CONTRACTOR for completion of the Work in accordance with the Contract Documents as stated in the Agreement.

18. Contract Times- The number of days or the dates stated in the Supplementary Conditions: (a) to achieve Substantial Completion, and (b) to complete the Work so that it is ready for final payment as evidenced by CITY's Representative's written recommendation of final payment.

19. CONTRACTOR- The person, firm, partnership, company, corporation or association licensed or otherwise authorized by law to do business in Missouri, with whom CITY has entered into the Agreement.

20. Day- Shall constitute a Calendar Day.

21. DESIGN PROFESSIONAL- Architect, Engineer or other licensed professional who is either employed by or has contracted with CITY to serve in a design capacity and whose Consultants, members, partners, employees or agents have prepared and sealed the Drawings and Specifications.

The DESIGN PROFESSIONAL(s) is identified and their seals affixed on the Certification Page(s). The certifications describe the respective responsibilities for the Drawings and Specifications prepared by the DESIGN PROFESSIONAL and are incorporated into this Contract.

22. DESIGN PROFESSIONAL's Project Representative- The authorized representative of DESIGN PROFESSIONAL who may be assigned to the Site or any part thereof.

23. Director- The term Director shall mean the duly appointed executive officer of a department of City who is empowered by the City Charter or by the City Council to enter into a contract on behalf of City, or to grant a permit for improvements to land owned by City. A Director is authorized to delegate this authority to a City employee so designated in writing.

24. Drawings- The drawings which graphically show the scope, extent and character of the Work to be furnished and performed by CONTRACTOR and which have been prepared by DESIGN PROFESSIONAL and are included in the Contract Documents. Shop Drawings are not Drawings as so defined.

25. Effective Date of the Contract- The date indicated in the Contract on which it becomes effective, but if no such date is indicated it means the date on which the Contract is fully executed by CITY.

26. General Requirements- Sections of Division 1 of the Specifications. The General Requirements pertain to all sections of the Specifications.

27. Hazardous Environmental Condition- The presence at the Site of Asbestos, Lead-Based Paint, PCBs, Petroleum, Hazardous Waste, or Radioactive Material in such quantities or circumstances that may present a substantial danger to persons or property exposed thereto in connection with the Work.

28. Hazardous Waste- The term Hazardous Waste shall have the meaning provided in Section 1004 of the Solid Waste Disposal Act (42 USC Section 6903) as amended from time to time.

29. Laws or Regulations- Any and all applicable laws, rules, regulations, ordinances, codes and orders of any and all governmental bodies, agencies, authorities and courts having jurisdiction.

30. Lead-Based Paint- Any paint, varnish, stain, or other applied coating that has one (1) mg or more of lead per square centimeter. The terms "leaded paint" and "lead-containing paint" are synonymous with Lead-Based Paint.

31. Liens- Liens, charges, security interests or encumbrances upon real property or personal property.

32. Milestone- A principal event specified in the Contract Documents relating to an intermediate completion date or time prior to Substantial Completion of all the Work.

33. Notice of Intent to Contract- The written notice by CITY to the apparent successful Bidder stating that upon compliance by that apparent successful Bidder with the conditions in the Bid Documents enumerated, within the time specified, and upon enactment of an appropriate ordinance or resolution, CITY will sign and deliver the Contract.

34. Notice to Proceed- A written notice given by CITY to CONTRACTOR fixing the date on which the Contract Times will commence to run and on which CONTRACTOR shall start to perform CONTRACTOR's obligations under the Contract Documents.

35. Partial Utilization- Use by CITY of a substantially completed part of the Work for the purpose for which it is intended (or a related purpose) prior to Substantial Completion of all the Work.

36. PCBs- Polychlorinated biphenyls.

37. Petroleum- Petroleum, including crude oil or any fraction thereof which is liquid at standard conditions of temperature and pressure (60 degrees Fahrenheit and 14.7 pounds per square inch absolute), such as oil, petroleum, fuel oil, oil sludge, oil refuse, gasoline, kerosene, and oil mixed with other non-Hazardous Wastes and crude oils.

38. Project- The total construction of which the Work to be provided under the Contract Documents may be the whole, or a part as indicated elsewhere in the Contract Documents.

39. Project Manual- The documentary information prepared for bidding and constructing the Work. A listing of the contents of the Project Manual may be issued in one or more volumes and is contained in the table(s) of contents.

40. Radioactive Material- Source, special nuclear, or byproduct material as defined by the Atomic Energy Act of 1954 (42 USC Section 2011 et seq.) as amended from time to time.

41. Samples- Physical examples of materials, equipment, or workmanship that are representative of some portion of the Work and which establish the standards by which such portion of the Work will be judged.

42. Shop Drawings- All drawings, diagrams, illustrations, schedules and other data or information which are specifically prepared or assembled by or for CONTRACTOR and submitted by CONTRACTOR to illustrate some portion of the Work.

43. Site- Lands or areas indicated in the Contract Documents as being furnished by CITY upon which the Work is to be performed, including rights-of-way and easements for access thereto, and such other lands furnished by CITY which are designated for the use of CONTRACTOR.

44. Specifications- Those portions of the Contract Documents consisting of written technical descriptions of materials, equipment, construction systems, standards and workmanship as applied to the Work and certain administrative details applicable thereto.

45. Subcontractor- Any individual, firm, partnership, company, corporation or association licensed or otherwise authorized by law to do business in Missouri, to whom CONTRACTOR, with written notification to CITY, has entered into an agreement to perform a part of the Work.

46. Substantial Completion- When Work (or a specified part thereof) has progressed to the point where, in the opinion of DESIGN PROFESSIONAL as evidenced by DESIGN PROFESSIONAL's definitive certificate of Substantial Completion, it is sufficiently complete, in accordance with the Contract Documents, so that the Work (or specified part) can be utilized for the purposes for which it is intended. The terms "substantially complete" and "substantially completed" as applied to all or part of the Work refer to Substantial Completion thereof.

47. Supplementary Conditions- The part of the Contract Documents which amends and/or supplements these General Conditions.

48. Supplier- A manufacturer, fabricator, supplier, distributor, materialman or vendor having a direct contract with CONTRACTOR or with any Subcontractor to furnish materials or equipment to be incorporated into the Work by CONTRACTOR or any Subcontractor.

49. Underground Facilities- All pipelines, conduits, ducts, cables, wires, manholes, vaults, tanks, tunnels or other such facilities or attachments, and any encasements containing such facilities which have been installed underground to furnish any of the following services or materials: electricity, gases, steam, liquid petroleum products, telephone or other communications, cable television, water, wastewater, storm water, other liquids or chemicals, or traffic or other control systems.

50. Unit Price Work- Work to be paid for on the basis of unit prices.

51. Work- The entire completed construction or the various separately identifiable parts thereof required to be furnished under the Contract Documents. Work includes and is the result of performing or furnishing labor, and furnishing and incorporating material and equipment into the construction, and furnishing documents, all as required by the Contract Documents.

52. Work Change Directive- A written directive to CONTRACTOR, issued on or after the Effective Date of the Contract, signed by CITY and recommended by DESIGN PROFESSIONAL, ordering an addition, deletion or revision in the Work, or responding to differing or unforeseen subsurface or physical conditions under which the Work is to be performed, or to emergencies. A Work Change Directive will not change the Contract Price or the Contract Times, but is evidence that the parties expect that the change directed or

documented by a Work Change Directive will be incorporated in a subsequently issued Change Order following negotiations by the parties as to its effect, if any, on the Contract Price or Contract Times.

53. Work Day - Any day during which the CONTRACTOR is able to work a period of six (6) hours or more. Days that are not Work Days are days during which the CONTRACTOR is unable to work for a period of six (6) hours by reason of strikes, boycotts, labor disputes, embargoes, unusual delays in transportation or shortage of material, acts of God, acts of the public enemy, acts of superior governmental authority, weather conditions, riots, rebellion, sabotage, or any other circumstances for which CONTRACTOR is not responsible or which is not within its control. Saturdays, Sundays, and holidays on which the CONTRACTOR's forces engage in Work requiring the presence of an inspector, will be considered as Work Days.

54. Written Amendment- A written statement modifying the Contract Documents, signed by CITY and CONTRACTOR on or after the Effective Date of the Contract and normally dealing with the non-engineering or non-technical rather than strictly construction-related aspects of the Contract Documents.

1.02 Terminology

A. Intent of Certain Terms or Adjectives

1. Whenever in the Contract Documents the terms "as ordered," "as directed," "as required," "as allowed," "as approved," or terms of like effect or import are used, or the adjectives "reasonable," "suitable," "acceptable," "proper" or "satisfactory" or adjectives of like effect or import are used to describe a requirement, direction, review or judgment of DESIGN PROFESSIONAL as to the Work, it is intended that such requirement, direction, review or judgment will be solely to evaluate, in general, the completed Work for compliance with the requirements of and information in the Contract Documents and conformance with the design concept of the completed Project as a functioning whole as shown or indicated in the Contract Documents (unless there is a specific statement indicating otherwise). The use of any such term or adjective shall not be effective to assign to DESIGN PROFESSIONAL any duty or authority to supervise or direct the furnishing or performance of the Work or any duty or authority to undertake responsibility contrary to the provisions of Paragraph 9.08 or any other provision of the Contract Documents.

B. Defective

1. The word "defective," when modifying the word "Work," refers to Work that is unsatisfactory, faulty or deficient, in that it does not conform to the Contract Documents, or does not meet the requirements of any inspection, reference standard, test or approval referred to in the Contract Documents, or has been damaged prior to CITY 's Representative's recommendation of final payment (unless responsibility for the protection thereof has been assumed by CITY at Substantial Completion in accordance with Paragraph 14.04 or 14.05).

C. Furnish, Install, Perform, Provide

1. The word "furnish," when used in connection with services, materials, or equipment, shall mean to supply and deliver said services, materials, or equipment to the Site (or some other specified location) ready for use or installation and in usable or operable condition.

2. The word "install," when used in connection with services, materials, or equipment, shall mean to put into use or place in final position said services, materials, or equipment complete and ready for intended use.

3. The words "perform" or "provide," when used in connection with services, materials, or equipment, shall mean to furnish and install said services, materials, or equipment complete and ready for intended use.

4. When “furnish,” “install,” “perform,” or “provide” is not used in connection with services, materials, or equipment in a context clearly requiring an obligation of CONTRACTOR, “provide” is implied.

D. Unless stated otherwise in the Contract Documents, words and phrases which have a well-known technical or construction industry or trade meanings are used in the Contract Documents in accordance with such recognized meaning.

ARTICLE 2 PRELIMINARY MATTERS

2.01 Delivery of Bonds

A. CONTRACTOR shall deliver to CITY such Bonds as CONTRACTOR may be required to furnish.

2.02 Evidence of Insurance

A. CONTRACTOR shall deliver to CITY certificates of insurance or other evidence of insurance that CITY may request, which CONTRACTOR is required to purchase and maintain in accordance with Article 5 or any other applicable provision in the Contract Documents.

2.03 Copies of Documents

A. CITY shall furnish to CONTRACTOR one (1) copy of the Drawings and Specifications, including addenda.

2.04 Commencement of Contract Times; Notice to Proceed

A. The Contract Times will commence to run on the date indicated in the Notice to Proceed.

2.05 Starting the Work

A. CONTRACTOR shall start to perform the Work on the date when the Contract Times commence to run, but no Work shall be done at the Site prior to the date on which the Contract Times commence to run, unless otherwise indicated in the Notice to Proceed.

2.06 Before Starting Construction

A. CONTRACTOR's Review of Contract Documents: Before undertaking each part of the Work, CONTRACTOR shall carefully study and compare the Contract Documents and check and verify pertinent figures shown thereon and all applicable field measurements. CONTRACTOR shall promptly report in writing to DESIGN PROFESSIONAL any conflict, error, ambiguity or discrepancy which CONTRACTOR may discover and shall obtain a written interpretation or clarification from DESIGN PROFESSIONAL before proceeding with any Work affected thereby. CONTRACTOR shall not be liable to CITY or DESIGN PROFESSIONAL for failure to report any conflict, error, ambiguity or discrepancy in the Contract Documents, unless CONTRACTOR knew or reasonably should have known thereof.

B. Preliminary Schedules: Within ten (10) days after the Effective Date of the Contract, or on such later date as CITY's Representative shall provide in writing, CONTRACTOR shall submit to CITY's Representative for review:

1. Preliminary Project Schedule: CONTRACTOR shall submit a proposed project schedule for CITY's acceptance. The proposed project schedule shall include a detailed and comprehensive construction schedule utilizing a critical path method diagram network that (a) shows all major procurement and construction elements and phases of the Project; (b) breaks down each element or phase by trade; (c) shows early and late starts so that all float time will be accurately identified; (d) all other activities necessary for the timely completion of the Project in accordance with the scheduled dates for Substantial and Final Completion; and (e) highlights the project's critical path. CITY's acceptance is expressly limited to CITY's acknowledgement that, based upon CITY's limited review, the dates of Substantial

Completion and Milestone dates are acceptable. After final acceptance of the preliminary project schedule by the CITY, it shall be considered the project baseline schedule pursuant to Paragraph 2.07(B).

2. Preliminary schedule of Shop Drawings and Sample submittals which will list each required submittal and the times for submitting, reviewing and processing such submittal; and

3. Preliminary 01290.02 Schedule of Values for all of the Work which will include quantities and prices of items which when added together equals the Contract Price and will subdivide the Work into component parts in sufficient detail to serve as the basis for progress payments during performance of the Work. Such prices will include an appropriate amount of overhead and profit applicable to each item of Work.

C. Preconstruction Conference: Before any Work at the Site may be started, a conference attended by CONTRACTOR, DESIGN PROFESSIONAL and others, as appropriate, will be scheduled by CITY's Representative to establish a working understanding among the parties as to the Work and to discuss the schedules referred to in Paragraph 2.06 B, procedures for handling Shop Drawings and other submittals, processing Applications for Payment, maintaining required records, Claims process, dispute resolution or any other applicable provisions of the Contract Documents.

2.07 Acceptable Schedules

A. Acceptable schedule: The Contractor shall update and submit to the CITY for review the preliminary schedule within seven (7) Calendar Days after the Notice to Proceed.

1. The CITY shall review and make any necessary comments and/or adjustments to the updated preliminary schedule. The Contractor shall incorporate the CITY's comments and resubmit the updated preliminary schedule within seven (7) Calendar Days from receipt of the CITY's comments.

B. Project Baseline Schedule: The accepted updated preliminary schedule shall be considered the project baseline schedule and shall be used by the CONTRACTOR for planning, scheduling, managing, and executing the Work. The project baseline schedule shall not be changed without the written consent of CITY. The project baseline schedule may be further modified by the Supplemental Conditions.

C. CONTRACTOR's schedule of values will be acceptable to CITY's Representative as to form and substance if it provides a reasonable allocation of the Contract Price to component parts of the Work.

ARTICLE 3 CONTRACT DOCUMENTS : INTENT, AMENDING, REUSE

3.01 Intent

A. The Contract Documents comprise the entire Contract between CITY and CONTRACTOR concerning the Work.

B. It is the intent of the Contract Documents to describe a functionally complete Project (or part thereof) to be constructed in accordance with the Contract Documents. Any Work, materials or equipment that may reasonably be inferred from the Contract Documents or from prevailing custom or trade usage as being required to produce the intended result will be furnished and performed whether or not specifically called for at no additional cost to CITY. Clarifications and interpretations of the Contract Documents shall be issued by DESIGN PROFESSIONAL as provided in Paragraph 9.03.

C. Correlation and intent of documents: The Drawings and Specifications are intended to supplement each other. Any Work shown on the Drawings and not mentioned in the Specifications (or vice versa) shall be as binding and shall be completed the same as if mentioned or shown on both. In the event of conflicts or discrepancies among the Contract Documents, interpretations will be based on the following priorities:

1. Change Orders and Written Amendments
2. Project Baseline Schedule Requirements
3. Approved Shop Drawings
4. Addenda, with those of later date having precedence over those of earlier date
5. The Supplementary Conditions
6. The General Conditions
7. Drawings and Specifications

D. In the case of an inconsistency between Drawings and Specifications, the requirements of the Specifications shall govern. If Drawings are in conflict, larger scale details shall govern over smaller or no-scale Drawings. If Specification sections are in conflict with each other, the conflict shall be resolved by DESIGN PROFESSIONAL in accordance with reasonable interpretation of such documents.

E. The general character of the detailed Work is shown on the Drawings, but minor modifications may be made in the full size or scale details. Where the word "similar" occurs on the Drawings, it shall be used in its general sense and not as meaning identical, and all details shall be worked out in relation to their location and their connection to the other parts of the Work. Where on any Drawings a portion of the Work is drawn out and the remainder is indicated in outline, the parts drawn out shall apply also to all other like portions of the Work. Where ornaments or other details are indicated by starting only, such details shall be continued throughout the courses or parts in which they occur and shall also apply to all other similar parts in the Work, unless otherwise indicated.

3.02 Reference to Standards and Specifications of Technical Societies

A. Reference to standards, specifications, manuals or codes of any technical society, organization or association, or to Laws or Regulations, whether such reference be specific or by implication, shall mean the latest standard, specification, manual, code or Laws or Regulations in effect at the time of opening of Bids (or on the date of CONTRACTOR's proposal if there are no Bids), except as may be otherwise specifically stated in the Contract Documents.

1. No provision of any such standard, specification, manual, code or instruction of Supplier shall be effective to change the duties or responsibilities of CITY, CONTRACTOR or DESIGN PROFESSIONAL, or any of their Subcontractors, Consultants, agents, or employees from those set forth in the Contract Documents, nor shall it be effective to assign to CITY or DESIGN PROFESSIONAL or any of their Consultants, agents or employees any duty or authority to supervise or direct the furnishing or performance of the Work or any duty or authority to undertake responsibility inconsistent with the provisions of the Contract Documents.

3.03 Reporting and Resolving Discrepancies

A. Reporting Discrepancies: If, during the performance of the Work, CONTRACTOR discovers any conflict, error, ambiguity or discrepancy within the Contract Documents or between the Contract Documents and any provision of any Laws or Regulations applicable to the performance of the Work or of any standard, specification, manual, code or any instruction of any Supplier referred to in Paragraph 6.07, CONTRACTOR shall report it immediately to DESIGN PROFESSIONAL in writing. CONTRACTOR shall not proceed with the Work affected thereby (except in an emergency as authorized by Paragraph 6.17) until an amendment or supplement to the Contract Documents has been issued by one of the methods indicated in Paragraph 3.04; provided, however, that CONTRACTOR shall not be liable to CITY or DESIGN PROFESSIONAL for failure to report any such conflict, error, ambiguity or discrepancy unless CONTRACTOR knew or reasonably should have known thereof.

B. Resolving Discrepancies. The provisions of the Contract Documents shall take precedence in resolving any conflict, error, ambiguity or discrepancy between the provisions of the Contract Documents and:

1. the provisions of any standard, specification, manual, code or instruction (whether or not specifically incorporated by reference in the Contract Documents); or
2. the provisions of any Laws or Regulations applicable to the performance of the Work.

3.04 Amending and Supplementing Contract Documents

A. The Contract Documents may be amended to provide for additions, deletions and revisions in the Work or to modify the terms and conditions thereof in one or more of the following ways:

1. a Written Amendment or
2. a Change Order (pursuant to Article 10), whether pursuant to a Work Change Directive or otherwise.

B. The requirements of the Contract Documents may be supplemented and minor variations and deviations in the Work may be authorized, in one or more of the following ways

1. DESIGN PROFESSIONAL's approval of a Shop Drawing or Sample (pursuant to Paragraph 6.18), or
2. DESIGN PROFESSIONAL's written interpretation or clarification (pursuant to Paragraph 9.03).

3.05 Reuse of Documents

A. CONTRACTOR and any Subcontractor or Supplier or other person or organization performing or furnishing any of the Work under this Contract:

1. shall not have or acquire any title to or ownership rights in any of the Drawings, Specifications or other documents (or copies of any thereof) prepared by or bearing the seal of DESIGN PROFESSIONAL or Consultant, and
2. shall not reuse any of such Drawings, Specifications, other documents or copies thereof on extensions of the Project or any other project without written consent of CITY, and of DESIGN PROFESSIONAL or Consultant, as applicable, and specific written verification or adaptation by DESIGN PROFESSIONAL or Consultant.

This prohibition will survive final payment, completion, and acceptance of the Work, or termination or completion of the Contract. Nothing herein shall preclude CONTRACTOR from retaining copies of the Contract Documents for record purposes.

ARTICLE 4 AVAILABILITY OF LANDS; SUBSURFACE AND PHYSICAL CONDITIONS; REFERENCE POINTS

4.01 Availability of Lands

A. CITY shall furnish the Site. CITY shall identify any encumbrances or restrictions not of general application but specifically related to use of lands so furnished with which CONTRACTOR will have to comply in performing the Work. Easements for permanent structures or permanent changes in existing facilities will be obtained and paid for by CITY, unless otherwise provided in the Contract Documents. If CONTRACTOR and CITY are unable to agree on entitlement to or the amount or extent of any adjustments in the Contract Price or the Contract Times or both as a result of any delay in CITY's furnishing these lands, rights-of-way or easements, CONTRACTOR may make a Claim as provided in Article 16. CONTRACTOR shall provide for all additional lands and access thereto that may be required for temporary construction facilities or storage of materials and equipment.

4.02 Subsurface and Physical Conditions

A. Reports and Drawings: Reference is made to the Supplementary Conditions for identification of:

1. Subsurface Conditions: Those reports of explorations and tests of subsurface conditions at or contiguous to the Site that have been utilized by DESIGN PROFESSIONAL in preparing the Contract Documents; and
2. Physical Conditions: Those drawings of physical conditions in or relating to existing surface or subsurface structures at or contiguous to the Site (except Underground Facilities) that have been utilized by DESIGN PROFESSIONAL in preparing the Contract Documents.

B. Limited Reliance by CONTRACTOR on Technical Data Authorized: CONTRACTOR may rely upon the general accuracy of the technical data contained in reports and drawings of subsurface or physical conditions, but such reports and drawings are not Contract Documents. The technical data is identified in the Supplementary Conditions. Except for reliance on such technical data, CONTRACTOR may not rely upon or make any Claim against CITY, DESIGN PROFESSIONAL or any Consultant with respect to:

1. the completeness of such reports and drawings for CONTRACTOR's purposes, including, but not limited to, any aspects of the means, methods, techniques, sequences and procedures of construction to be employed by CONTRACTOR and safety precautions and programs incident thereto; or
2. other data, interpretations, opinions and information contained in such reports or shown or indicated in such drawings, or
3. any CONTRACTOR interpretation of or conclusion drawn from any technical data or any such other data, interpretations, opinions or information.

4.03 Differing Subsurface or Physical Conditions

A. Notice of Differing Subsurface or Physical Conditions. If CONTRACTOR believes that any subsurface or physical condition at or contiguous to the Site that is uncovered or revealed either:

1. is of such a nature as to establish that any technical data on which CONTRACTOR is entitled to rely as provided in Paragraphs 4.02 A and 4.02 B is materially inaccurate; or
2. is of such a nature as to require a change in the Contract Documents; or
3. differs materially from that shown or indicated in the Contract Documents; or
4. is of an unusual nature, and differs materially from conditions ordinarily encountered and generally recognized as inherent in work of the character provided for in the Contract Documents; then CONTRACTOR shall, promptly after becoming aware thereof and before further disturbing the subsurface or physical conditions or performing any Work in connection therewith (except in an emergency as required by Paragraph 6.17), notify CITY and DESIGN PROFESSIONAL in writing about such condition(s). CONTRACTOR shall not further disturb such conditions or perform any Work in connection therewith (except as aforesaid) until receipt of written order to do so.

B. DESIGN PROFESSIONAL's Review: After receipt of notice as required by Paragraph 4.03 A, DESIGN PROFESSIONAL will promptly review the pertinent conditions, determine the necessity for CITY to obtain additional exploration or tests with respect thereto and notify CITY in writing (with a copy to CONTRACTOR) of DESIGN PROFESSIONAL's findings and conclusions.

C. Possible Contract Documents Change: If CITY concludes that a change in the Contract Documents is required as a result of a condition that meets one or more of the categories in Paragraph 4.03 A, a Work Change Directive or a Change Order will be issued as provided in Article 10 to reflect and document the consequences of such change.

D. Possible Price or Times Adjustments: An equitable adjustment in the Contract Price or in the Contract Times, or both, will be allowed to the extent that the existence of a subsurface or physical condition causes an increase or decrease in CONTRACTOR's cost of, or time required for, performance of the Work; subject, however, to the following:

1. the condition must meet any one or more of the categories described in Paragraphs 4.03 A.1 through 4.03 A.4, inclusive;
2. a change in the Contract Documents pursuant to Paragraph 4.03 C will not be an automatic authorization of, nor a condition precedent to, entitlement to any such adjustments;
3. with respect to Work that is paid for on a unit price basis, any adjustment in Contract Price will be subject to the provisions of Paragraphs 9.06 and 11.04; and
4. CONTRACTOR shall not be entitled to any adjustment in the Contract Price or Contract Times if;
 - a. CONTRACTOR knew, or by the exercise of ordinary care could have known, of such conditions at the time CONTRACTOR made a final commitment to CITY with respect to Contract Price and Contract Times by the submission of a Bid; or
 - b. the existence of such condition could reasonably have been discovered or revealed as a result of any examination, investigation, exploration, test or study of the Site and contiguous areas required by the Bidding Requirements or Contract Documents to be conducted by or for CONTRACTOR prior to CONTRACTOR's making such final commitment; or
 - c. CONTRACTOR failed to give the written notice as required by Paragraph 4.03 A.

E. If CITY and CONTRACTOR are unable to agree on entitlement to, or magnitude of, an equitable adjustment in the Contract Price pursuant to Article 11 and/or Contract Times pursuant to Article 12, a Claim may be made therefore as provided in Article 16. However, CITY, DESIGN PROFESSIONAL and Consultants shall not be liable to CONTRACTOR for any costs, losses or damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all other dispute resolution costs) sustained by CONTRACTOR on or in connection with any other project or anticipated project.

4.04. Physical Conditions – Underground Facilities

A. Shown or Indicated: The information and data shown or indicated in the Contract Documents with respect to existing Underground Facilities at or contiguous to the Site is based on information and data furnished to CITY or DESIGN PROFESSIONAL by the owners of such Underground Facilities or by others.

1. CITY and DESIGN PROFESSIONAL shall not be responsible for the accuracy or completeness of any such information or data; and
2. The cost of all of the following will be included in the Contract Price and CONTRACTOR shall have full responsibility for:
 - a. reviewing and checking all such information and data,
 - b. locating all Underground Facilities shown or indicated in the Contract Documents,
 - c. coordination of the Work with the owners of such Underground Facilities during construction, and
 - d. the safety and protection of all such Underground Facilities as provided in Paragraph 6.14 and repairing any damage thereto resulting from the Work.

B. Not Shown or Indicated: If an Underground Facility is uncovered or revealed at or contiguous to the Site, and was not shown or indicated in the Contract Documents, or was

shown or indicated incorrectly in the Contract Documents, CONTRACTOR shall, promptly after becoming aware thereof and before further disturbing conditions affected thereby or performing any Work in connection therewith (except in an emergency as required by Paragraph 6.17), identify the owner of such Underground Facility and give written notice to that owner and to CITY and DESIGN PROFESSIONAL.

C. DESIGN PROFESSIONAL's Review: After receipt of notice as required by Paragraph 4.04 B, DESIGN PROFESSIONAL will promptly review the consequences of the existence of the Underground Facility and notify CITY in writing (with a copy to CONTRACTOR) of DESIGN PROFESSIONAL's findings and conclusions.

D. Possible Contract Documents Change: If CITY concludes that a change in the Contract Documents is required as a result of the existence of an Underground Facility that either was not shown, or was shown incorrectly, in the Contract Documents, a Work Change Directive or Change Order will be issued as provided in Article 10 to reflect and document the consequences of such change.

E. Possible Price or Times Adjustments: An equitable adjustment in the Contract Price or in the Contract Times, or both, will be allowed to the extent that the existence of the Underground Facility causes an increase or decrease in CONTRACTOR's cost of, or time required for, performance of the Work; subject, however, to the following:

1. a change in the Contract documents pursuant to Paragraph 4.04 D will not be an automatic authorization of, nor a condition precedent to, entitlement to any such adjustments;
2. with respect to Work that is paid for on a unit price basis, any adjustment in Contract Price will be subject to the provisions of Paragraphs 9.06 and 11.04; and
3. CONTRACTOR shall not be entitled to any adjustment in the Contract Price or Contract Times if;
 - a. CONTRACTOR knew, or by the exercise of ordinary care could have known, of the existence of the Underground Facility at the time CONTRACTOR made a final commitment to CITY with respect to Contract Price and Contract Times by the submission of a Bid; or
 - b. the existence of the Underground Facility could reasonably have been discovered or revealed as a result of any examination, investigation, exploration, test or study of the Site and contiguous areas required by the Bidding Requirements or Contract Documents to be conducted by or for CONTRACTOR prior to CONTRACTOR's making such final commitment; or
 - c. CONTRACTOR failed to give the written notice as required by Paragraph 4.04 B.

F. If CITY and CONTRACTOR are unable to agree on entitlement to, or magnitude of, an equitable adjustment in the Contract Price pursuant to Article 11 and/or Contract Times pursuant Article 12, a Claim may be made therefore as provided in Article 16. However, CITY, DESIGN PROFESSIONAL and Consultants shall not be liable to CONTRACTOR for any costs, losses or damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all other dispute resolution costs) sustained by CONTRACTOR on or in connection with any other project or anticipated project.

4.05 Reference Points

A. CITY shall provide engineering surveys to establish reference points for construction that in DESIGN PROFESSIONAL's judgment are necessary to enable CONTRACTOR to proceed with the Work. CONTRACTOR shall be responsible for laying out the Work, shall protect and preserve the established reference points and property monuments, and shall make no changes or relocations without the prior written approval of CITY. CONTRACTOR shall report to DESIGN PROFESSIONAL whenever any reference point or property monument is lost or destroyed or requires relocation because of necessary changes in grades or locations, and shall be

responsible for the accurate replacement or relocation of such reference points or property monuments by professionally qualified personnel.

4.06 Asbestos, Lead-Based Paint, PCBs, Petroleum, Hazardous Waste or Radioactive Material

A. Reports and Drawings: Reference is made to the Supplementary Conditions for the identification of those reports and drawings relating to a Hazardous Environmental Condition identified at the Site, if any, that have been utilized by the DESIGN PROFESSIONAL in the preparation of the Contract Documents.

B. Limited Reliance by CONTRACTOR on Technical Data Authorized: CONTRACTOR may rely upon the general accuracy of the technical data contained in reports and drawings relating to a Hazardous Environmental Condition at the Site, but such reports and drawings are not Contract Documents. Such technical data is identified in the Supplementary Conditions. Except for such reliance on such technical data, CONTRACTOR may not rely upon or make any Claim against CITY, DESIGN PROFESSIONAL or any Consultant with respect to:

1. the completeness of such reports and drawings for CONTRACTOR's purposes, including, but not limited to, any aspects of the means, methods, techniques, sequences and procedures of construction to be employed by CONTRACTOR and safety precautions and programs incident thereto; or
2. other data, interpretations, opinions and information contained in such reports or shown or indicated in such drawings; or
3. any CONTRACTOR interpretation of or conclusion drawn from any technical data or any such other data, interpretations, opinions or information.

C. CONTRACTOR shall not be responsible for any Hazardous Environmental Condition uncovered or revealed at the Site which was not shown or indicated in Drawings or Specifications or identified in the Contract Documents to be within the scope of the Work. CONTRACTOR shall be responsible for all Hazardous Environmental Conditions created with any materials brought to the Site by CONTRACTOR, Subcontractors, Suppliers, or anyone else for whom CONTRACTOR is responsible. CONTRACTOR shall not be entitled to an extension of the Contract Times or an increase in the Contract Price if CONTRACTOR, Subcontractor, Supplier or anyone for whom CONTRACTOR is responsible created any Hazardous Environmental Condition at the Site or in connection with the Work.

D. If CONTRACTOR encounters a Hazardous Environmental Condition at the Site or if CONTRACTOR or anyone for whom CONTRACTOR is responsible creates a Hazardous Environmental Condition at the Site, CONTRACTOR shall immediately:

1. secure or otherwise isolate such condition;
2. stop all Work in connection with such condition and in any area affected thereby (except in an emergency as required by Paragraph 6. 15); and
3. notify CITY and DESIGN PROFESSIONAL (and promptly thereafter confirm such notice in writing). CITY shall promptly consult with DESIGN PROFESSIONAL concerning the necessity for CITY to retain a qualified expert to evaluate such condition or take corrective action, if any.

E. CONTRACTOR shall neither resume Work nor be required to resume Work in connection with such condition or in any affected area until after CITY has obtained any required permits related thereto and delivered to CONTRACTOR written notice:

1. specifying that such condition and any affected area is or has been rendered safe for the resumption of Work; or
2. specifying any special conditions under which such Work may be resumed safely. If CITY and CONTRACTOR cannot agree as to entitlement to or on the amount or extent, if any, of any adjustment in Contract Price pursuant to Article 11 and/or Contract Times to

pursuant to Article 12 as a result of such Work stoppage or such special conditions under which Work is agreed to be resumed by CONTRACTOR, a Claim may be made therefore as provided in Article 16.

F. If after receipt of written notice as required in Paragraph 4.06 E, CONTRACTOR does not agree to resume Work based on a reasonable belief it is unsafe, or does not agree to resume such Work under special conditions specified in the notice, then CITY may order the portion of the Work that is in the area affected by such condition to be deleted from the Work. If CITY and CONTRACTOR cannot agree as to entitlement to or magnitude of an equitable adjustment in Contract Price pursuant to Article 11 and/or Contract Times pursuant to Article 12 as a result of deleting such portion of the Work, then a Claim may be made therefore as provided in Article 16. CITY may have such deleted portion of the Work performed by CITY's own forces or others in accordance with Article 7.

G. The provisions of Paragraphs 4.02, 4.03, and 4.04 are not intended to apply to a Hazardous Environmental Condition uncovered or revealed at the Site.

H. All materials used, whether new or salvaged, shall be asbestos-free materials. CONTRACTOR shall immediately call to the attention of the CITY's Representative any specified material or product which the CONTRACTOR knows or suspects to contain asbestos, whether new or salvaged.

ARTICLE 5 BONDS AND INSURANCE

5.01 Performance, Payment and Other Bonds

A. CONTRACTOR shall furnish Performance and Maintenance and Payment Bonds, each in an amount at least equal to the Contract Price, as set out in the Contract Documents, as security for the faithful performance and payment of all CONTRACTOR's obligations under the Contract Documents. These Bonds shall remain in effect at least until one (1) year after the date when final payment of the Contract becomes due, except as provided otherwise by Laws or Regulations or by the Contract Documents. CONTRACTOR shall also furnish such other Bonds as are required by the Supplementary Conditions.

B. All Bonds shall be in the form prescribed by the Contract Documents except as provided otherwise by Laws or Regulations. A certified copy of the agent's authority to act must accompany all Bonds signed by an agent.

C. If the surety on any Bond furnished by CONTRACTOR is declared bankrupt or becomes insolvent, or its right to do business is terminated in any state where any part of the Project is located or it ceases to meet the requirement of Paragraph 5.01 B, CONTRACTOR shall within twenty (20) days thereafter substitute another Bond and surety, both of which must be acceptable to CITY.

5.02 Licensed Sureties and Insurers

A. All Bonds and insurance required by the Contract Documents to be purchased and maintained by CITY or CONTRACTOR shall be obtained from surety or insurance companies that are duly licensed in the State of Missouri and in the jurisdiction in which the Project is located, if not in Missouri, to issue Bonds or insurance policies for the limits and coverages so required. All surety and insurance companies shall hold an A.M. Best rating of A-, V, or better.

5.03 Certificates of Insurance

A. CONTRACTOR shall deliver to CITY and DESIGN PROFESSIONAL, prior to the start of any Work at the Project Site, properly completed certificates of insurance or other evidence that the required insurance is in full force and effect, in a form acceptable to CITY. The receipt or acceptance of a certificate of insurance that does not incorporate the required terms and coverage shall not constitute a waiver by the City of the insurance requirements contained in the Contract Documents.

B. All policies of insurance (and the certificates or other evidence thereof) required to be purchased and maintained by CONTRACTOR in accordance with Paragraphs 5.04 and 5.06 will contain waiver provisions in accordance with Paragraph 5.07 A. The certificates of insurance will contain a provision stating that should any of the policies described in the certificate be cancelled before the expiration date thereof, notice will be delivered in accordance with the policy provisions.

C. If the coverage afforded is cancelled or changed or its renewal is refused, CONTRACTOR shall give at least thirty (30) days prior written notice to CITY and to each other additional insured to whom a certificate of insurance has been issued.

5.04 CONTRACTOR's Liability Insurance

A. CONTRACTOR shall purchase and maintain such liability and other insurance as is appropriate for the Work being performed and furnished, and will provide protection from claims set forth below which may arise out of or result from CONTRACTOR's performance and furnishing of the Work and CONTRACTOR's other obligations under the Contract Documents, whether it is to be performed or furnished by CONTRACTOR, any Subcontractor or Supplier, or by anyone directly or indirectly employed by any of them to perform or furnish any of the Work, or by anyone for whose acts any of them may be liable:

1. claims under workers' compensation, disability benefits and other similar employee benefit acts;
2. claims for damages because of bodily injury, occupational sickness or disease, or death of CONTRACTOR's employees;
3. claims for damages because of bodily injury, sickness or disease, or death of any person other than CONTRACTOR's employees;
4. claims for damages insured by customary personal injury liability coverage;
5. claims for damages, other than to the Work itself, because of injury to or destruction of tangible property wherever located, including loss of use resulting therefore; and
6. claims for damages because of bodily injury or death of any person or property damage arising out of the ownership, maintenance or use of any motor vehicle.

B. The policies of insurance so required by Paragraph 5.04 A, to be purchased and maintained shall:

1. with respect to insurance required by Paragraphs 5.04 A.3 through 5.04 A.5 inclusive, include as additional insureds (subject to any customary exclusion for professional liability) CITY, DESIGN PROFESSIONAL, Consultants and any other individuals or entities identified in the Supplementary Conditions to be listed as additional insureds, and include coverage for the respective officers, directors, partners, employees, agents, and other consultants and subcontractors of each and any of all such additional insureds, and the insurance afforded to these additional insureds shall provide primary coverage for all claims covered thereby;
2. include at least the specific coverages and be written for not less than the limits of liability provided in Paragraph 5.04 C or required by Laws or Regulations, whichever is greater;
3. include completed operations insurance;
4. include contractual liability insurance covering CONTRACTOR's indemnity obligations;
5. remain in effect at least until final payment and at all times thereafter when CONTRACTOR may be correcting, removing or replacing defective Work in accordance with Paragraphs 13.06 and 13.07;

6. with respect to completed operations insurance, and any insurance coverage written on a claims-made basis, remain in effect for at least two (2) years after final payment (and CONTRACTOR shall furnish CITY and each other additional insured identified in the Supplementary Conditions to whom a certificate of insurance has been issued evidence satisfactory to CITY and any such additional insured of continuation of such insurance);

7. contain a cross-liability or severability of interest clause or endorsement. Insurance covering the specified additional insureds shall be primary insurance, and all other insurance carried by the additional insureds shall be excess insurance;

8. with respect to commercial automobile liability, commercial general liability, and umbrella liability insurance, CONTRACTOR shall require its insurance carrier(s) to waive all rights of subrogation against CITY, and CITY's officers, directors, partners, employees and agents; and

9. contain a provision or endorsement that the costs of providing the insureds a defense and appeal, including attorneys fees, as insureds, shall be supplementary and shall not be included as part of the policy limits but shall remain the insurer's responsibility.

C. Specific policies of insurance required by this Paragraph 5.04 shall include:

1. Workers' Compensation and Employers' Liability Insurance. This insurance shall protect CONTRACTOR against all claims under applicable state workers' compensation laws, including coverage as necessary for the benefits provided under the United States Longshoremen's and Harbor Workers' Act and the Jones Act. CONTRACTOR shall also be protected against claims for injury, disease, or death of employees which, for any reason, may not fall within the provisions of workers' compensation laws. This policy shall include an "all states" or "other states" endorsement. The liability limits shall be not less than:

Workers' Compensation: Statutory

Employers' liability: \$1,000,000 each occurrence

2. Commercial Automobile Liability Insurance. This insurance shall be occurrence type written in comprehensive form and shall protect CONTRACTOR, and CITY, DESIGN PROFESSIONAL and Consultants against all claims for injuries to members of the public and damage to property of others arising from the use of motor vehicles, either on or off the Project Site, whether they are owned, non-owned, or hired.

The liability limits shall be not less than: \$2,000,000

3. Commercial General Liability Insurance. This insurance shall be occurrence type written in comprehensive form acceptable to CITY. This insurance shall protect CONTRACTOR, and CITY, DESIGN PROFESSIONAL and Consultants as additional insureds, against claims arising from injuries, sickness, disease, or death of any person or damage to property arising out of performance of the Work. The policy shall also include coverage for personal injury liability; contractual liability; completed operations and products liability; and for blasting, explosion, and collapse of buildings; and damage to underground property. The liability limits for bodily injury and property damage shall be not less than:

\$2,000,000 combined single limit for each occurrence

\$2,000,000 general aggregate.

4. The insurer's costs of providing the insureds a defense and appeal as additional insureds, including attorney's fees, shall be supplementary and shall not be included as part of the policy limits but shall remain the insurer's separate responsibility.

5.05 CITY's Liability Insurance

A. In addition to the insurance required to be provided by CONTRACTOR under Paragraph 5.04, CITY, at CITY's option, may purchase and maintain at CITY's expense liability insurance

that will protect CITY against claims which may arise from operations under the Contract Documents.

5.06 Property Insurance

A. Unless otherwise provided in the Supplementary Conditions, CONTRACTOR shall purchase and maintain property insurance on the Work at the Site in the amount of the full replacement cost thereof (subject to such deductible amounts as may be provided in the Supplementary Conditions or required by Laws or Regulations). This insurance shall:

1. include the interests of CITY, CONTRACTOR, Subcontractors, and any other persons or entities identified in the Supplementary Conditions, each of whom is deemed to have an insurable interest and shall be listed as an insured or additional insured;
2. be written on a Builder's Risk "all-risk" or open peril or special causes of loss policy form that shall at least include insurance for physical loss or damage to the Work, temporary buildings, falsework and materials and equipment in transit, and shall insure against at least the following perils or causes of loss: fire, lightning, extended coverage, theft, vandalism and malicious mischief, earthquake, tornado, collapse, debris removal, demolition occasioned by enforcement of Laws or Regulations, water damage, damage caused by frost and freezing, and acts of God;
3. be maintained in effect until final payment is made unless otherwise agreed to in writing by CITY with thirty (30) days written notice to each other additional insured to whom a certificate of insurance has been issued.

B. CITY shall not be responsible for purchasing and maintaining any property insurance to protect the interests of CONTRACTOR, Subcontractors or others involved in the Work to the extent of any deductible amounts. The risk of loss within the deductible amounts will be borne by CONTRACTOR, Subcontractor or others suffering any such loss and if any of them wishes property insurance coverage within the limits of such amounts, each may purchase and maintain it at the purchaser's own expense.

5.07 Waiver of Rights

A. CITY and CONTRACTOR intend that all policies purchased in accordance with Paragraphs 5.04 and 5.06 will protect CITY, CONTRACTOR, DESIGN PROFESSIONAL Consultants, Subcontractors, and all other persons or entities identified in the Supplementary Conditions to be listed as insureds or additional insureds in such policies and will provide primary coverage for all losses and damages caused by the perils covered thereby. All such policies shall contain provisions to the effect that in the event of payment of any loss or damage the insurers will have no rights of recovery against any of the insureds or additional insureds thereunder. CITY and CONTRACTOR waive all rights against each other and their respective officers, directors, partners, employees and agents for all losses and damages caused by, arising out of or resulting from any of the perils covered by such policies and any other property insurance applicable to the Work, but only to the extent of insurance coverage; and, in addition, waive all such rights against DESIGN PROFESSIONAL, Consultants, Subcontractors, and all other persons or entities identified in the Supplementary Conditions to be listed as insureds or additional insureds (and the officers, directors, partners, employees, agents, and other consultants and subcontractors of any and each of them) under such policies for losses and damages so caused and covered by insurance. None of the above waivers shall extend to the rights that any party making such waiver may have to the proceeds of insurance held by CITY as trustee or otherwise payable under any policy so issued. None of the above waivers shall apply if specifically in conflict with Laws and Regulations.

5.08 Receipt and Application of Insurance Proceeds

A. Any insured loss under the property insurance will be adjusted with CITY and made payable to CITY as fiduciary for the insureds, as their interests may appear, subject to the requirements of any indentures of indebtedness entered into by CITY.

B. CITY as fiduciary shall have power to adjust and settle any loss with the insurers unless one of the parties in interest shall object to CITY's exercise of this power in writing within fifteen (15) days after the occurrence of loss. If such objection is made, CITY as fiduciary shall make settlement with the insurers in accordance with such agreement as the parties in interest may reach. If no such agreement among the parties in interest is reached, CITY as fiduciary shall adjust and settle the loss with the insurers.

5.09 Partial Utilization – Property Insurance

A. If CITY finds it necessary to occupy or use a portion or portions of the Work prior to Substantial Completion of all the Work, such use or occupancy may be accomplished in accordance with Paragraph 14.05; provided that no such use or occupancy shall commence before the insurers providing the property insurance have acknowledged notice thereof and in writing effected any changes in coverage necessitated thereby. The insurers providing the property insurance shall consent by endorsement on the policy or policies, but the property insurance shall not be canceled or permitted to lapse on account of any such partial use or occupancy.

ARTICLE 6 CONTRACTOR'S RESPONSIBILITIES

6.01 Indemnification

A. For purposes of this Paragraph 6.01 only, the following terms shall have the meanings listed:

1. Claims means all claims, damages, liability, losses, costs and expenses, including court costs and reasonable attorneys' fees, including attorney's fees incurred by the City in the enforcement of this indemnity obligation.

2. CONTRACTOR'S Agents means CONTRACTOR's officers, employees, sub-consultants, subcontractors, successors, assigns, invitees, and other agents.

3. CITY means CITY, its Program Manager/Construction Advisor and any of their agents, officials, officers, employees and program managers or construction advisors.

B. CONTRACTOR's obligations under this Paragraph with respect to indemnification for acts or omissions, including negligence, of CITY, shall be limited to the coverage and limits of insurance that CONTRACTOR is required to procure and maintain under this Contract. CONTRACTOR affirms that it has had the opportunity to recover the costs of the liability insurance required in this Contract in its contract price.

C. CONTRACTOR shall defend, indemnify and hold harmless CITY from and against all Claims arising out of or resulting from all acts or omissions in connection with this Contract caused in whole or in part by CONTRACTOR or CONTRACTOR's Agents, regardless of whether or not caused in part by any act or omission, including negligence, of OWNER.

D. In any and all Claims against CITY, DESIGN PROFESSIONAL, CONSULTANT, or any of their respective agents, officers, directors or employees by any employee (or the survivor or personal representative of such employee) of CONTRACTOR, any Subcontractor, any Supplier, any person or organization directly or indirectly employed by any of them to perform or furnish any of the Work, or anyone for whose acts any of them may be liable, the indemnification obligation under Paragraph 6.01 C shall not be limited in any way by any limitation on the amount or type of damages, compensation or benefits payable by or for CONTRACTOR or any such Subcontractor, Supplier or other person or organization under workers' compensation acts, disability benefit acts or other employee benefit acts.

E. The indemnification obligations of CONTRACTOR under Paragraph 6.01 C shall not extend to liability arising out of, resulting from, or caused by the professional negligence, errors or omissions of DESIGN PROFESSIONAL, CONSULTANT, or any of their respective agents, officers, directors or employees.

6.02 Supervision and Superintendence

A. CONTRACTOR shall supervise, inspect and direct the Work competently and efficiently, devoting such attention thereto and applying such skills and expertise as may be necessary to perform the Work in accordance with the Contract Documents. CONTRACTOR shall be solely responsible for the means, methods, techniques, sequences and procedures of construction, but CONTRACTOR shall not be responsible for the negligence of others in the design or specification of a specific means, method, technique, sequence or procedure of construction which is shown or indicated in and expressly required by the Contract Documents. CONTRACTOR shall be responsible to see that the completed Work complies accurately with the Contract Documents.

B. At all times during the progress of the Work, CONTRACTOR shall assign a competent resident superintendent of the Work, who shall not be replaced without written request to and approval by CITY except under extraordinary circumstances. The superintendent will be CONTRACTOR's representative at the Site and shall have authority to act on behalf of CONTRACTOR. All communications given to or received from the superintendent shall be binding on CONTRACTOR.

C. If it is determined to be in the best interest of the Work, CONTRACTOR shall replace the project manager, resident superintendent or any other employee of the CONTRACTOR, Subcontractors, Suppliers or other persons or organizations performing or furnishing any of the Work on the project upon written request by the CITY.

6.03 Services, Working Hours, Labor, Materials and Equipment

A. CONTRACTOR shall provide competent, suitably qualified personnel to survey, lay out and construct or perform the Work as required by the Contract Documents. CONTRACTOR shall at all times maintain good discipline and order at the Site. Except as otherwise required for the safety or protection of persons or the Work or property at the Site or adjacent thereto, and except as otherwise indicated in the Contract Documents, all Work at the Site shall be performed during regular working hours. CONTRACTOR shall not permit overtime work or the performance of Work on Saturday, Sunday or any legal holiday without CITY's written consent given after prior written notice to DESIGN PROFESSIONAL.

B. Unless otherwise specified in Division 1, General Requirements, CONTRACTOR shall furnish and assume full responsibility for all services, materials, equipment, labor, transportation, construction equipment and machinery, tools, appliances, fuel, power, light, heat, telephone, water, sanitary facilities, temporary facilities and all other facilities and incidentals necessary for the furnishing, performance, testing, start-up and completion of the Work.

C. All materials and equipment shall be of good quality and new, except as otherwise provided in the Contract Documents. All warranties and guarantees specifically called for by the Specifications shall expressly run to the benefit of CITY. If required by DESIGN PROFESSIONAL, CONTRACTOR shall furnish satisfactory evidence (including reports of required tests) as to the source, kind, and quality of materials and equipment. All materials and equipment shall be stored, applied, installed, connected, erected, used, cleaned and conditioned in accordance with instructions of the applicable Supplier, except as otherwise provided in the Contract Documents.

D. It is the policy of the CITY that any manufactured goods or commodities used or supplied in the performance of this Contract and any subcontract hereto shall be manufactured or produced in the United States whenever possible.

6.04 Progress Schedule

A. CONTRACTOR shall adhere to the progress schedule established in accordance with Article 2 as it may be adjusted from time to time as provided below:

1. CONTRACTOR shall provide, at least once every thirty (30) calendar days, updated information on the project schedule, including thirty (30) day look ahead schedules, projected variances per event category and per Subcontractor, identification of all variances and calculation of the number of Days difference between the as-built critical path and the project schedule critical path

2. CONTRACTOR shall, with each application for payment, provide completed monthly updated status report for the previous month on the project schedule and updated information indicating as-built and as-planned conditions. The updated information on the project schedule shall not modify any Milestone dates in the project schedule that CITY has previously approved. The updated information required is a condition precedent to payment pursuant to paragraph 14.02 and shall include at a minimum:

- a. a concise statement of the outlook for meeting project schedule dates and the reasons for any change in outlook from the previous report;
- b. a review of any significant technical problems encountered during the month;
- c. an explanation of any corrective action taken or proposed; and
- d. a summary of any Claims anticipated by CONTRACTOR with respect to the Work, including the anticipated costs and schedule impacts of any such Claims.

6.05 Recovery Schedules

A. If the CONTRACTOR should:

1. fail, refuse or neglect to supply a sufficient number of workers or to deliver the materials or equipment with such promptness as to prevent the delay in the progress of the Work;

2. fail in any respect to commence and diligently prosecute the Work in accordance with the approved baseline project schedule in order to achieve substantial completion;

3. fail to commence, prosecute, finish, deliver or install the different portions of the Work on time as specified in the approved baseline project schedule; or

4. fail in the performance of any of the material covenants of the Contract Documents;

CITY shall have the right to direct the CONTRACTOR, upon seven (7) calendar days notice, to prepare a written recovery plan, for CITY's approval, to accelerate the Work in order to conform to the approved baseline project schedule, including, without limitation, providing additional labor or expediting delivery of materials, performing overtime or re-sequencing the Work without adjustments to the Contract value. Upon CITY's approval of the recovery plan, CONTRACTOR shall accelerate the Work in accordance with the plan.

B. Proposed recovery schedules shall be submitted to the CITY as a separate project plan for review and approval by CITY prior to incorporation into the approved baseline schedule. The recovery schedule shall be submitted in a format compatible with the baseline schedule format. Each proposed revision shall be submitted as a separate schedule, with the following minimum requirements:

1. A critical path method diagram showing revised and affected activities or Milestones.
2. An activity report for all revised and affected activities or Milestones.

C. Upon acceptance of the recovery schedule by CITY, data shall be added or revised for all new or revised activities and incorporated into the approved baseline project schedule.

6.06 Substitutes and “Or-Equal” Items

A. Materials or equipment: Whenever an item of material or equipment is specified or described in the Contract Documents by using the name of a proprietary item or the name of a particular Supplier, the specification or description is intended to establish the type, function, appearance and quality required. Unless the specification or description contains, or is followed by, words reading that no like, equivalent or ““or-equal”” item or no substitution is permitted, other items of material or equipment or material or equipment of other Suppliers may be submitted to CITY for review by CITY’s Representative under the following circumstances:

1. “Or-Equal”: If, prior to receipt of Bids, Bidder proposes an item of material or equipment as functionally equal to that named and sufficiently similar so that no change in related Work will be required, CITY’s Representative may request DESIGN PROFESSIONAL to consider it as an “or-equal” item. DESIGN PROFESSIONAL will review and recommend the acceptance, or rejection, of the proposed item to the CITY’s Representative. For the purposes of this Paragraph, a proposed item of material or equipment will be considered functionally equal to an item so named if:

a. in the exercise of reasonable judgment DESIGN PROFESSIONAL determines that:

(1) it is at least equal in quality, durability, appearance, strength, and design characteristics; and

(2) it will reliably perform at least equally well the function imposed by the design concept of the completed Project as a functioning whole; and

b. Bidder certifies that:

(1) there is no increase in cost to the CITY; and

(2) it will conform substantially, even with deviations, to the detailed requirements of the item named in the Contract Documents.

If the CITY’s Representative approves the proposed item, it may be accepted by CITY.

2. Substitute Items: If CONTRACTOR proposes an item of material or equipment as a substitute item, then CONTRACTOR shall submit sufficient information as provided below to allow CITY’s Representative to determine that the item of material or equipment proposed is essentially equivalent to that named and an acceptable substitute therefore. The procedure for review by the CITY’s Representative will include the following as supplemented in the General Requirements and as CITY’s Representative may determine is appropriate under the circumstances:

a. Requests for review of proposed substitute items of material or equipment will not be accepted by CITY’s Representative from anyone other than CONTRACTOR.

b. If CONTRACTOR wishes to furnish or use a substitute item of material or equipment, CONTRACTOR shall first make written application to CITY’s Representative for acceptance thereof.

c. In the application, CONTRACTOR shall certify that the proposed substitute will perform adequately the functions and achieve the results called for by the general design, be similar in substance to that specified and be suited to the same use as that specified. The application will state the extent, if any, to which the evaluation and acceptance of the proposed substitute will impact CONTRACTOR’s achievement of Substantial Completion, whether or not acceptance of the substitute for use in the Work will require a change in any of the Contract Documents (or in the provisions of any other direct contract with CITY for work on the Project) to adapt the design to the proposed substitute and whether or not incorporation or use of the substitute in connection with the Work is subject to payment of any license fee or royalty.

d. All variations of the proposed substitute from that specified will be identified in the application and available maintenance, repair and replacement service will be indicated. The application will also contain an itemized estimate of all costs or credits that will result directly or indirectly from acceptance of such substitute, including costs of redesign and claims of other contractors affected by the resulting change, all of which will be considered by CITY's Representative in evaluating the proposed substitute. CITY's Representative may require CONTRACTOR to furnish additional data about the proposed substitute.

If the CITY's Representative approves the proposed item, CITY may accept it.

B. Substitute Construction Methods or Procedures: If a specific means, method, technique, sequence or procedure of construction is shown or indicated in and expressly required by the Contract Documents, CONTRACTOR may furnish or utilize a substitute means, method, technique, sequence or procedure of construction acceptable to DESIGN PROFESSIONAL. CONTRACTOR shall notify CITY and submit sufficient information to allow DESIGN PROFESSIONAL, in DESIGN PROFESSIONAL's sole discretion, to determine that the substitute proposed is equivalent to that expressly called for by the Contract Documents.

C. Expenses: Bidder shall provide all data in support of any "or equal" at Bidder's expense, and CONTRACTOR shall provide all data in support of any proposed substitute at CONTRACTOR's expense.

D. Evaluation: DESIGN PROFESSIONAL and CITY's Representative will be allowed a reasonable time within which to evaluate each proposal or submittal made pursuant to Paragraphs 6.06 A, and 6.06 B. CITY will be the sole judge of acceptability. No "or-equal" or substitute will be ordered, installed or utilized without CITY's prior written acceptance which will be evidenced by either a Change Order or an approved Shop Drawing. CITY may require CONTRACTOR to furnish at CONTRACTOR's expense, a special performance guarantee or other surety with respect to any "or-equal" substitute. DESIGN PROFESSIONAL will record time required by DESIGN PROFESSIONAL and Consultants in evaluating substitutes proposed or submitted by CONTRACTOR pursuant to Paragraphs 6.06 A and 6.06 B and in making changes in the Contract Documents (or in the provisions of any other direct contract with CITY for work on the Project) occasioned thereby. Whether or not CITY accepts a substitute so proposed or submitted by CONTRACTOR, CONTRACTOR shall reimburse CITY for the reasonable charges of DESIGN PROFESSIONAL and Consultants for evaluating each such proposed substitute.

6.07 Concerning Subcontractors, Suppliers and Others

A. CONTRACTOR shall not employ or retain any Subcontractor, Supplier or other person or organization (including those acceptable to CITY as indicated in Paragraph 6.07 B), whether initially or as a substitute, against whom CITY has a reasonable objection, including but not limited to debarment by City or another governmental entity or decertification of the Subcontractor from the City's Minority and Women's Business Enterprise Program as a result of the Subcontractor's failure to comply with any of the requirements of the provisions of Chapter 38 of the City's Code as determined by the Director of the Human Relations Department. Contractor shall insert this provision in any subcontractor agreement associated with this Contract. CONTRACTOR shall not be required to employ any Subcontractor, Supplier or other person or organization to furnish or perform any of the Work against whom CONTRACTOR has reasonable objection. CONTRACTOR shall submit required information for all Subcontractors on Form 01290.09 - Sub-contractor and Major Material Suppliers List, provided in these Contract Documents, prior to Subcontractor beginning Work at the Site.

B. The Supplementary Conditions require the identity of certain Subcontractors, Suppliers or other persons or organizations (including those who are to furnish the principal items of materials or equipment) to be submitted to CITY on or before the date specified in the Supplementary Conditions, for acceptance by CITY. If CONTRACTOR has submitted a list

thereof in accordance with the Supplementary Conditions, CITY may accept (either in writing or by failing to make written objection thereto by the date indicated for acceptance or objection in the Contract Documents) any such Subcontractor, Supplier or other person or organization so identified, or may reject same on the basis of reasonable objection after due investigation, in which case CONTRACTOR shall submit an acceptable replacement for the rejected Subcontractor, Supplier or other person or organization. The Contract Price will be adjusted by the difference in the cost occasioned by such substitution, and an appropriate Change Order will be issued or Written Amendment signed. No acceptance by CITY of any such Subcontractor, Supplier or other person or organization shall constitute a waiver of any right of CITY or DESIGN PROFESSIONAL to reject defective Work.

C. CONTRACTOR shall be fully responsible to CITY for all acts and omissions of the Subcontractors, Suppliers and other persons and organizations performing or furnishing any of the Work under a direct or indirect contract with CONTRACTOR just as CONTRACTOR is responsible for CONTRACTOR's own acts and omissions. Nothing in the Contract Documents shall create for the benefit of any such Subcontractor, Supplier or other person or organization any contractual relationship between CITY or DESIGN PROFESSIONAL and any such Subcontractor, Supplier or other person or organization, nor shall it create any obligation on the part of CITY or DESIGN PROFESSIONAL to pay or to see to the payment of any moneys due any such Subcontractor, Supplier or other person or organization except as may otherwise be required by Laws or Regulations.

D. CONTRACTOR shall be solely responsible for scheduling and coordinating the Work of Subcontractors, Suppliers and other persons and organizations performing or furnishing any of the Work under a direct or indirect contract with CONTRACTOR.

E. CONTRACTOR shall contractually require all Subcontractors, Suppliers and such other persons and organizations performing or furnishing any of the Work to communicate with CITY and DESIGN PROFESSIONAL through CONTRACTOR.

F. The divisions and sections of the Specifications and the identifications of any Drawings shall not control CONTRACTOR in dividing the Work among Subcontractors or Suppliers or delineating the Work to be performed by any specific trade.

G. All Work performed for CONTRACTOR by a Subcontractor or Supplier shall be pursuant to an appropriate written agreement between CONTRACTOR and the Subcontractor or Supplier that specifically binds the Subcontractor or Supplier to the applicable terms and conditions of the Contract Documents for the benefit of CITY. Whenever any such agreement is with a Subcontractor or Supplier who is listed as an additional insured on the property insurance provided in Paragraph 5.06, the agreement between the CONTRACTOR and the Subcontractor or Supplier will contain provisions whereby the Subcontractor or Supplier waives all rights against CITY, CONTRACTOR, DESIGN PROFESSIONAL, Consultants and all other additional insureds for all losses and damages caused by, arising out of or resulting from any perils, to the extent covered by such policies and any other property insurance applicable to the Work. If the insurers on any such policies require separate waiver forms to be signed by any Subcontractor or Supplier, CONTRACTOR will obtain the same.

H. Except as otherwise provided in this subsection H and in accordance with the provisions of subsection C hereof, the agreement between CONTRACTOR and the Subcontractor or Supplier referred to in subsection G, shall provide that the CONTRACTOR and the Subcontractor or Supplier agree not to request CITY or CITY's Representative to intervene in or facilitate the resolution of claims or contract disputes arising out of or related to the agreement between CONTRACTOR and the Subcontractor or Supplier. Furthermore, the Contracts between CONTRACTOR and Subcontractors or Suppliers shall provide that all unresolved claims and disputes between CONTRACTOR and the Subcontractor or Supplier that remain unresolved after thirty (30) calendar days from the notice of claim, shall be subject to mediation as a condition precedent to the institution of legal proceedings by either party. Any such mediation shall be conducted in accordance with the CITY's Code Section 38-100.7.

I. CONTRACTOR shall not insert any provision in any subcontractor agreement associated with this Contract that explicitly states or implies that the subcontractor shall only be paid for work performed if or when the general CONTRACTOR is paid by the CITY . Contractor's compliance with this provision is a material term of this Contract.

6.08 Patent Fees and Royalties

A. CONTRACTOR shall pay all license fees and royalties and assume all costs incident to the use in the performance of the Work or the incorporation into the Work of any invention, design, process, product or device which is the subject of patent rights or copyrights held by others. If a particular invention, design, process, product or device is specified in the Contract Documents for use in the performance of the Work, and if to the actual knowledge of CITY or DESIGN PROFESSIONAL its use is subject to patent rights or copyrights calling for the payment of any license fee or royalty to others, the existence of such rights shall be disclosed by CITY in the Contract Documents. To the fullest extent permitted by Laws or Regulations, CONTRACTOR shall defend, indemnify and hold harmless CITY, DESIGN PROFESSIONAL, Consultants and the officers, directors, employees, agents and other consultants of each and any of them from and against all claims, costs, losses and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or resulting from any infringement of patent rights or copyrights incident to the use in the performance of the Work or resulting from the incorporation into the Work of any invention, design, process, product or device not specified in the Contract Documents.

6.09 Permits

A. Unless otherwise provided in the Supplementary Conditions, CONTRACTOR shall obtain and pay for all construction permits and licenses. CITY shall assist CONTRACTOR, when necessary, in obtaining such permits and licenses. CONTRACTOR shall pay all governmental charges and inspection fees necessary for the prosecution of the Work, which are applicable at the time of opening of Bids, or, if there are no Bids, on the Effective Date of the Contract. CONTRACTOR shall pay all charges of utility owners for connections to the Work.

B. CONTRACTOR, at its own expense, shall comply with all Federal, State and local laws and regulations, including, but not limited to the Missouri Clean Water Law (Chapter 644 RSMo) together with any accompanying regulation(s) contained in the Missouri Code of State Regulations (CSR Title 10), as well as any implementing permits, together with any CITY Provisions during the life of this Contract including but not limited to:

1. Approvals and permits as required for construction or land disturbance activities.
2. Compliance with the State of Missouri – Department of Natural Resources (“MDNR”) Missouri State Operating Permit (“Land Disturbance Permit”), MO-R100006 for all construction or land disturbance activity.
3. Development and implementation of a Storm Water Pollution Prevention Plan (SWPPP).
 - (a) Contractor shall not commence land disturbance activity until the initial SWPPP has been finalized.
 - (b) Preparation and submittal of all applications, documentation and exhibits required to obtain MDNR approvals for uninterrupted Work at the Site.
 - (c) Amending/Updating SWPPP.
 - (d) Site Inspections and submittal of Inspection Reports
 - (e) Proper Operation and Maintenance to achieve compliance with the terms of the Permit.

(f) Maintenance of required records in accordance with MDNR requirements and requirements included in Article 6 of these Contract Documents.

4. In addition to requirements of Article 6, Contractor shall also provide record access to Missouri Department of Natural Resources (MDNR).

5. Failure to control erosion and water pollution is a permit violation. CONTRACTOR shall have 24 hours after receiving notice of the violation to correct the problem. If the CONTRACTOR fails to correct the problem after the time prescribed, the City will hire a remediation expert to fix the problem. In such an event, the CONTRACTOR shall be liable to the City for the remediation costs plus a 10% mark-up of the total contract price. If the CONTRACTOR receives three (3) notices of violation of the erosion control plan and the City's MS4 permit, the Director may issue a stop work order and delay any payment until control measures are properly functioning and stream damage has been mitigated. In such an event, any delay to the project schedule will result in liquidated damages assessed against the CONTRACTOR.

6.10 Compliance with Laws and Regulations

A. CONTRACTOR shall give all notices and comply with all Laws or Regulations applicable to furnishing and performing the Work. Except where otherwise expressly required by applicable Laws or Regulations, neither CITY nor DESIGN PROFESSIONAL shall be responsible for monitoring CONTRACTOR's compliance with any Laws or Regulations. The Laws or Regulations included in this Paragraph shall include, but not be limited to, those set forth in the Supplementary Conditions.

B. Failure to Comply. If CONTRACTOR performs any Work in violation of applicable Laws or Regulations, CONTRACTOR shall bear all claims, costs, losses and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) caused by, arising out of or resulting therefrom; however, it shall not be CONTRACTOR's primary responsibility to make certain that the Specifications and Drawings are in accordance with Laws or Regulations, but this shall not relieve CONTRACTOR of CONTRACTOR's obligations under Paragraph 3.03.

C. Conflicts of Interest. The provisions of City's Code Sections 2-1015 and 2-1764, prohibiting City officers and employees from having a financial or personal interest in any contract with City, and Code Sections 2-1016 and 2-1770, imposing sanctions for violations, shall apply to this Contract. CONTRACTOR certifies that no officer or employee of City has, or will have, a direct or indirect financial or personal interest in this Contract, and that no officer or employee of City, or member of such officer's or employee's immediate family, either has negotiated, or has or will have an arrangement concerning employment to perform services on behalf of CONTRACTOR on this Contract.

D. Licenses and Permits. CONTRACTOR, at its own expense, shall secure or cause to be secured all licenses and permits from public or private sources necessary for the fulfillment of its obligations under this Contract. All references in this Contract to the "Code" shall mean City's Code of Ordinances, including any amendments thereto or re-codification thereof unless the context clearly indicates otherwise. CONTRACTOR shall obtain copies of all necessary licenses and permits from Subcontractors required for the Work before Subcontractors begin Work at the Site. CONTRACTOR shall retain such evidence in its files and make available to CITY within ten (10) days after CITY's written request.

E. Americans with Disabilities Act. CONTRACTOR agrees to comply, during the course of this Contract, with all provisions of the Americans with Disabilities Act, 42 U.S.C. Sec. 12101 et seq., as well as 28 CFR Parts 35 and 36 and 29 CFR Part 1630, as applicable and as amended from time to time.

F. Affirmative Action. If the Contract Price exceeds \$300,000.00 and CONTRACTOR employs fifty (50) or more people, CONTRACTOR shall comply with City's Affirmative Action requirements in accordance with the provisions of Chapter 38 of City's Code, the rules and

regulations relating to those sections, and any additions or amendments thereto. CONTRACTOR shall not discriminate against any employee or applicant for employment because of race, color, sex, religion, national origin or ancestry, disability, sexual orientation, gender identity or age in a manner prohibited by Chapter 38 of City's Code.

CONTRACTOR shall:

1. Submit, in print or electronic format, a copy of CONTRACTOR'S current certificate of compliance to the City's Human Relations Department (HRD) prior to receiving the first payment under the contract, unless a copy has already been submitted to HRD at any point within the previous two calendar years. If, and only if, CONTRACTOR does not possess a current certification of compliance, CONTRACTOR shall submit, in print or electronic format, a copy of its affirmative action program to HRD prior to receiving the first payment under the contract, unless a copy has already been submitted to HRD at any point within the previous two calendar years.

2. Require any Subcontractor awarded a subcontract exceeding \$300,000.00 to affirm that Subcontractor has an affirmative action program in place and will maintain the affirmative action program in place for the duration of the subcontract.

3. Obtain from any Subcontractor awarded a subcontract exceeding \$300,000.00 a copy of the Subcontractor's current certificate of compliance and tender a copy of the same, in print or electronic format, to HRD within thirty (30) days from the date the subcontract is executed. If, and only if, Subcontractor does not possess a current certificate of compliance, CONTRACTOR shall obtain a copy of the Subcontractor's affirmative action program and tender a copy of the same, in print or electronic format, to HRD within thirty (30) days from the date the subcontract is executed.

City has the right to take action as directed by City's Human Relations Department to enforce this provision. If CONTRACTOR fails, refuses or neglects to comply with the provisions of Chapter 38 of City's Code, then such failure shall be deemed a total breach of this Contract and this Contract may be terminated, canceled or suspended, in whole or in part, and CONTRACTOR may be declared ineligible for any further contracts funded by City for a period of one (1) year. This is a material term of this Contract.

G. Minority and Women Business Enterprises and Workforce. City is committed to ensuring that minorities and women participate to the maximum extent possible in the performance of City's construction contracts. If minority and women business enterprise (M/WBE) goals have been set for this Contract, CONTRACTOR agrees to comply with all requirements of City's Minority and Women's Business Enterprise Program as enacted in City's Code, Sections 38-84 through 38-100.8 and as hereinafter amended. CONTRACTOR shall meet or exceed both the MBE and WBE goals set forth in its Contractor Utilization Plan/Request for Waiver. If workforce utilization goals are applicable to this Contract, CONTRACTOR agrees to comply with all requirements of City's Construction Employment Program as enacted in City's Code, Sections 38-83.1 through 38-83.13 and as hereinafter amended. CONTRACTOR shall meet or exceed the construction employment goals unless the same shall have been waived in the manner provided by law. CONTRACTOR's compliance with this provision is a material part of this Contract.

H. Records.

1. For purposes of this section:

(a) "City" shall mean the City Auditor, the City's Internal Auditor, the City's Director of Human Relations, the City Manager, the City department administering this Contract and their delegates and agents.

(b) "Record" shall mean any document, book, paper, photograph, map, sound recordings or other material, regardless of physical form or characteristics, made or received in connection with this Contract and all Contract amendments and renewals.

2. Contractor shall maintain and retain all Records for a term of five (5) years that shall begin after the expiration or termination of this Contract and all Contract amendments. City

shall have a right to examine or audit all Records and Contractor shall provide access to City of all records upon ten (10) days written notice from the City.

I. Prevailing Wage.

1. CONTRACTOR shall comply and require its Subcontractors to comply with;
 - a. sections 290.210 to 290.340, RSMO the State of Missouri Prevailing Wage Law (the "Law"); and
 - b. 8 CSR 30-3.010 to 8 CSR 30-3.060, the Prevailing Wage Law Rules (the "Rules"); and
 - c. the Annual Wage Order (Wage Order) issued by the State of Missouri's Department of Labor and Industrial Relations; and
 - d. any applicable Annual Incremental Wage Increase (Wage Increase) to the Annual Wage Order.

2. The Law, Rules, Annual Wage Order and any Wage Increase are incorporated into and made part hereof this Contract and shall be collectively referred to in this Section as the "Prevailing Wage Requirements."

3. CONTRACTOR shall pay and require its Subcontractors to pay to all workers performing work under this Contract not less than the prevailing hourly rate of wages for the class or type of work performed by the worker in accordance with the Law, Rules, Wage Order and any applicable Wage Increase. CONTRACTOR shall take whatever steps are necessary to insure that the prevailing hourly wage rates are paid and that all workers for CONTRACTOR and each of its Subcontractors are paid for the class or type of work performed by the worker in accordance with the Prevailing Wage Requirements. If CONTRACTOR shall fail to start to perform CONTRACTOR's obligations under the Contract Documents within sixty (60) days from the Effective Date of the Contract, CONTRACTOR and each of its subcontractors shall be obligated to pay all workers in accordance with any new Wage Order, as subsequently amended by any applicable Wage Increase, issued by the Department of Labor and Industrial Relations within the aforementioned sixty (60) day period. The new Wage Order and any applicable Wage Increase shall govern notwithstanding the fact that the Wage Order being replaced might be physically attached or incorporated in the Contract Documents.

4. Prior to each of its Subcontractors beginning Work on the Site, CONTRACTOR shall require each Subcontractor to complete CITY's Form 00490 entitled "Pre-contract Certification" that sets forth the Subcontractor's prevailing wage and tax compliance history for the two (2) years prior to the bid. CONTRACTOR shall retain one (1) year and make the Pre-contract Certifications available to CITY within five (5) days after written request.

5. CONTRACTOR shall keep and require each of its Subcontractors engaged in the construction of public works in performance of the Contract to keep full and accurate records on CITY's:

- a. "Certified Payroll Report" Form indicating the worker's name, address, social security number, occupation(s) and craft(s) of every worker employed in connection with the public work together with the number of hours worked by each worker and the actual wages paid in connection with the Project; and
- b. "Daily Labor Force Report" Form indicating the worker's name, occupational title or classification group & skill and the workers' hours. CITY shall furnish blank copies of the Daily Labor Force Report Form to CONTRACTOR for its use and for distribution to Subcontractors; and
- c. "Payroll Certification" Form. CONTRACTOR shall prepare and shall require each Subcontractor to prepare a "Payroll Certification" Form to accompany the Certified Payroll Report. The Payroll Certification must be signed by the employee or agent who

pays or supervises the payment of the workers employed under the Contract for the CONTRACTOR and each Subcontractor.

d. Copies of CITY's "Certified Payroll Report" form, the Daily Labor Force Report and Payroll Certification Form are included in the Project Manual and are collectively referred to in this Section as the "Records."

6. CONTRACTOR shall submit its and its Subcontractors Daily Labor Force Reports to CITY each day. CONTRACTOR shall make all of CONTRACTOR's and Subcontractors' Records open to inspection by any authorized representatives of OWNER and the Missouri Department of Labor and Industrial Relations at any reasonable time and as often as they may be necessary and such Records shall not be destroyed or removed from the State of Missouri for a period of one (1) year following the completion of the public work in connection with which the Records are made. CONTRACTOR shall have its and its Subcontractors Certified Payroll Reports and Payroll Certifications available at the CONTRACTOR's office and shall provide the Records to the City electronically at City's sole discretion. In addition, all Records shall be considered a public record and CONTRACTOR shall provide the Records to the CITY in the format required by the CITY within three (3) working days of any request by CITY at the CONTRACTOR's cost. CITY, in its sole discretion, may require CONTRACTOR to send any of the Records directly to the person who requested the Record at CONTRACTOR's expense.

7. CONTRACTOR shall post and keep posted a clearly legible statement of all prevailing hourly wage rates to be paid to all workers employed by CONTRACTOR and each of its Subcontractors in the performance of this Contract in a prominent and easily accessible place at the Site of the Work by all workers.

8. If the Contract Price exceeds \$250,000.00, CONTRACTOR shall and shall require each Subcontractor engaged in any construction of public works to have its name, acceptable abbreviation or recognizable logo and the name of the city and state of the mailing address of the principal office of the company, on each motor vehicle and motorized self-propelled piece of equipment which is used in connection with the Project during the time the CONTRACTOR or Subcontractor is engaged on the project. The sign shall be legible from a distance of twenty (20') feet, but the size of the lettering need not be larger than two (2") inches. In cases where equipment is leased or where affixing a legible sign to the equipment is impractical, the CONTRACTOR may place a temporary stationary sign, with the information required pursuant to this section, at the main entrance of the Project in place of affixing the required information on the equipment so long as such sign is not in violation of any state or federal statute, rule or regulation. Motor vehicles which are required to have similar information affixed thereto pursuant to requirements of a regulatory agency of the state or federal government are exempt from the provisions of this subsection.

9. CONTRACTOR must correct any errors in CONTRACTOR's or any Subcontractors' Records, or CONTRACTOR's or any Subcontractors' violations of the Law, Rules, Annual Wage Order and any Wage Increase within fourteen (14) calendar days after notice from CITY.

10. CONTRACTOR shall and shall require its Subcontractors to cooperate with the CITY and the Department of Labor and Industrial Relations in the enforcement of this Section, the Law, Rules, Annual Wage Order and any Wage Increase. Contractor shall and shall require its Subcontractors to permit CITY and the Department of Labor and Industrial Relations to interview any and all workers during working hours on the Project at CONTRACTOR's sole cost and expense.

11. CONTRACTOR shall file with CITY, upon completion of the Project and prior to final payment therefore, affidavits from CONTRACTOR and each of its Subcontractors, stating that each has fully complied with the provisions and requirements of the Missouri Prevailing Wage Law. CITY shall not make final payment until the affidavits, in proper form and order, from CONTRACTOR and each of its Subcontractors, are filed by CONTRACTOR.

12. CONTRACTOR shall forfeit as a statutory penalty to the CITY one hundred dollars (\$100.00) for each worker employed, for each calendar day, or portion thereof, such worker is paid less than the prevailing hourly rates for any work done under this Contract, by CONTRACTOR or by any of CONTRACTOR's Subcontractors. If CONTRACTOR or any of its Subcontractors have violated any section(s) of 290.210 to 290.340, RSMo, in the course of the execution of the Contract, CITY shall when making payments to the CONTRACTOR becoming due under this Contract, withhold and retain therefrom all sums and amounts due and owing as a result of any violation of sections 290.210 to 290.340, RSMo.

J. Prevailing Wage Damages. CONTRACTOR acknowledges and agrees that, based on the experience of CITY, violations of the Missouri Prevailing Wage Act, whether by CONTRACTOR or its Subcontractors, commonly result in additional costs to CITY. CONTRACTOR agrees that additional costs to CITY for any particular violation are difficult to establish and include but are not limited to: costs of construction delays, additional work for CITY, additional interest expenses, investigations, and the cost of establishing and maintaining a special division working under the City Manager to monitor prevailing wage compliance.

1. In the event of the failure by CONTRACTOR or any of its Subcontractors to pay wages as provided in the Missouri Prevailing Wage Act, CITY shall be entitled to deduct from the Contract Price, and shall retain as liquidated damages, one hundred dollars (\$100.00) per day, per worker who is paid less than the prevailing hourly rate of wages, to approximate the additional costs. The sum shall be deducted, paid or owed whether or not the Contract Times have expired.

2. CITY shall give written notice to CONTRACTOR setting forth the workers who have been underpaid, the amount of the statutory penalty and the amount of the liquidated damages as provided for in this Subparagraph J. CONTRACTOR shall have fourteen (14) calendar days to respond, which time may be extended by CITY upon written request. If CONTRACTOR fails to respond within the specified time, the CITY's original notice shall be deemed final. If CONTRACTOR responds to CITY's notice, CITY will furnish CONTRACTOR a final decision in writing within five (5) days of completing any investigation.

K. Missouri Secretary of State Business Entity Registration. CONTRACTOR shall obtain from all Subcontractors for the Project, a copy of their current certificate of good standing or fictitious name registration from the Missouri Secretary of State before they begin work on the Site. CONTRACTOR shall retain such documents in its files and make available to CITY within ten (10) days after written request.

L. Tropical Hardwoods. The provisions of Code Section 2-1872, restricting the use of tropical hardwoods, shall apply to this Contract.

M. Preference for Missouri Products. Pursuant to Section 71.140 RSMo., preference shall be given to materials, products, supplies and all other articles produced, manufactured, made or grown within the State of Missouri.

N. Guidelines for Open Excavations.

1. CONTRACTOR shall restore required excavations to the level of the adjacent surfaces as soon as practicable. Unsupervised open excavations on public properties are discouraged at all times. If CONTRACTOR, in performance of the Work, makes or causes to be made any excavation in, upon, under, through or adjoining any street, sidewalk, alley, park, boulevard, parkway or any other public properties, and shall leave any part or portion thereof open, CONTRACTOR shall provide effective protection to the public.

2. CONTRACTOR shall protect and secure all excavations in roadways in compliance with existing federal, state and local codes and standards, including, but not limited to the most current edition of the Manual of Uniform Traffic Control Devices. CONTRACTOR shall protect and secure all unsupervised excavations not within roadways, either by covering or fencing.

a. Covering. A protective cover that can sustain the weight of persons or of objects that are placed upon it may be installed over an unsupervised excavation. The cover shall be secured to the ground to prevent movement. Protective covers shall have no opening(s) or protuberance(s) of sufficient size to cause a fall and/or injury. Advance warning devices shall be installed as necessary.

b. Fencing. Fencing to prevent entry may be installed surrounding an unsupervised excavation not protectively covered in its entirety. The fencing shall be a minimum of 42" in height. The fencing shall be constructed in such a manner that it is adequately secured and will remain upright at all times under normal Site conditions. All protective coverings and fences over and around excavations shall be inspected at least daily to assure integrity. Protective coverings and/or fences in heavily trafficked areas shall be inspected more often as necessary.

O. Notification of Utilities. CONTRACTOR shall adhere to the provisions of Sections 319.010 et seq., RSMo., which requires that a person or firm making an excavation in any public street, road or alley, right of way dedicated to public use, utility easement of record, or within any private street or private property do so only after giving notice to, and obtaining information from, owners of Underground Facilities. The 24-hour, toll-free accident prevention hotline number in Missouri is 1-800-344-7483 (1-800-Digrite).

P. Employee Eligibility Verification. CONTRACTOR shall adhere to the provisions of Sections 285.525 et seq., RSMo., which requires that for any contract exceeding five thousand dollars (\$5,000.00), CONTRACTOR shall execute and submit an affidavit, in a form prescribed by CITY, affirming that CONTRACTOR does not knowingly employ any person in connection with the contracted services who does not have the legal right or authorization under federal law to work in the United States as defined in 8 U.S.C. § 1324a(h)(3). CONTRACTOR shall attach to the affidavit documentation sufficient to establish CONTRACTOR'S enrollment and participation in an electronic verification of work program operated by the United States Department of Homeland Security (E-Verify) or an equivalent federal work authorization program operated by the United States Department of Homeland Security to verify information of newly hired employees, under the Immigration Reform and Control Act of 1986. CONTRACTOR may obtain additional information about E-Verify and enroll at <https://e-verify.uscis.gov/enroll/StartPage.aspx?JS=YES>. For those Contractors enrolled in E-Verify, the first and last pages of the E-Verify Memorandum of Understanding that CONTRACTOR will obtain upon successfully enrolling in the program shall constitute sufficient documentation for purposes of complying with this Section. CONTRACTOR shall submit the affidavit and attachments to CITY prior to execution of the Contract, or at any point during the term of the Contract if requested by City.

Q. OSHA 10-Hour Training Requirement. CONTRACTOR and any subcontractor working under this Contract shall require every employee on the Site to complete a ten-hour construction safety program which meets the requirements of Section 292.675, RSMo, except for those employees who shall have previously completed the required program and hold documentation to that effect. CONTRACTOR shall remove or require the removal of any person from the Site who is subject to this requirement and who does not complete or is unable to produce documentation of their successful completion of the required program within the time limitations prescribed by Section 292.675, RSMo. CONTRACTOR shall forfeit the sum of two thousand five hundred dollars (\$2,500.00), in addition to one hundred dollars (\$100.00) per employee each calendar day, or portion thereof, the employee(s) shall continue to be employed without having completed the required program within the time limitations prescribed by Section 292.675, RSMo. CITY shall be entitled to withhold and retain any amounts due and owing hereunder when making payment to CONTRACTOR.

R. Clean Air Act and Clean Water Act. CONTRACTOR shall comply with requirements of the Clean Air Act (42 U.S.C. 7401 et seq.); Clean Water Act (33 U.S.C. 1251 et seq.), Missouri Clean Water Law (Chapter 644 RSMo), Code of Federal regulations (Title 40: Protection of

Environment, Title 33: Navigation and Navigable Waters) and the rules of the Missouri Code of State Regulations (CSR Title 10).

6.11 Taxes

A. CONTRACTOR shall pay all sales, consumer, use and other similar taxes required to be paid by CONTRACTOR in accordance with the Laws or Regulations of the place of the Project which are applicable during the performance of the Work.

B. Tax Compliance.

1. As a condition precedent to CITY making its first payment to CONTRACTOR under this Contract, CONTRACTOR shall furnish to CITY sufficient proof from City's Commissioner of Revenue, dated not more than one (1) year prior to the date provided to CITY, verifying that CONTRACTOR is in compliance with the license and tax ordinances administered by City's Revenue Division of the Finance Department.

2. As a condition precedent to Subcontractors performing any Work under this Contract, CONTRACTOR shall obtain from Subcontractor sufficient proof from City's Commissioner of Revenue, dated not more than one (1) year before the date Subcontractor begins Work, verifying that the Subcontractor is in compliance with the license and tax ordinances administered by City's Revenue Division of the Finance Department. CONTRACTOR shall retain such documentation in its files and make available to CITY within ten (10) days after a written request.

3. As a condition precedent to CITY making final payment under this Contract, if this Contract is longer than one (1) year and exceeds the dollar threshold established by ordinance and included in the Supplementary Conditions, CONTRACTOR shall furnish to CITY sufficient proof from City's Commissioner of Revenue, dated not more than one (1) year before the filing of a final Application for Payment, verifying that CONTRACTOR is in compliance with the license and tax ordinances administered by City's Revenue Division of the Finance Department.

4. If this Contract is longer than one (1) year and exceeds the dollar threshold established by ordinance and included in the Supplementary Conditions, CONTRACTOR shall obtain from Subcontractors sufficient proof from City's Commissioner of Revenue, dated not more than one (1) year before the date of CONTRACTOR's final payment to the Subcontractor, that the Subcontractor was or is in compliance with the license and tax ordinances administered by City's Revenue Division of the Finance Department. CONTRACTOR shall retain such documentation in its files and make available to CITY within ten (10) days after written request.

5. If, at the time of final payment to CONTRACTOR, CONTRACTOR is unable to obtain from all its Subcontractors, if any, and furnish to CITY sufficient proof from City's Commissioner of Revenue that all its Subcontractors are in compliance with the license and tax ordinances administered by City's Revenue Division of the Finance Department, CITY may approve final payment to CONTRACTOR if CITY determines that CONTRACTOR has made a good faith effort to furnish evidence or that there are other extenuating circumstances which make it impossible for CONTRACTOR to furnish sufficient proof.

C. Missouri Sales Tax Exemption. Pursuant to Section 144.062, RSMo, CITY is a Missouri exempt entity and tangible personal property to be incorporated or consumed in the construction of this Project may be purchased without sales tax. CITY shall furnish CONTRACTOR a Missouri Project Exemption Certificate for Sales Tax at the time of issuance of the Notice to Proceed.

6.12 Use of Site and Other Areas

A. CONTRACTOR shall confine construction equipment, the storage of materials and equipment, and the operations of workers to the Site and other areas identified in and permitted by the Contract Documents and other areas permitted by Laws or Regulations. CONTRACTOR

shall not unreasonably encumber the Site and the other areas with construction equipment or other materials or equipment. CONTRACTOR shall assume full responsibility for any damage to the Site or the other areas, or to the owner or occupant thereof, or of any adjacent land or areas, resulting from the performance of the Work.

B. Should any claim be made by any such owner or occupant because of the performance of the Work, CONTRACTOR shall promptly settle with such other party by negotiation or otherwise resolve the claim by arbitration or other dispute resolution proceeding or at law. In case of a failure on the part of the CONTRACTOR to restore such property or to make good such damage or injuries, the CITY may, upon forty-eight (48) hours written notice to the CONTRACTOR, repair, rebuild or otherwise restore such property as the CITY may deem necessary, and the cost thereof will be deducted from any moneys due or which may become due the CONTRACTOR under this Contract.

C. CONTRACTOR shall, to the fullest extent permitted by Laws or Regulations, defend, indemnify and hold harmless CITY, DESIGN PROFESSIONAL, Consultants and the officers, directors, employees, agents and other consultants of each and any of them from and against all claims, costs, losses and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or resulting from any claim or action, legal or equitable, brought by any such owner or occupant against CITY, DESIGN PROFESSIONAL or any other party indemnified hereunder to the extent caused by or based upon CONTRACTOR's performance of the Work.

D. During the progress of the Work, CONTRACTOR shall keep the Site and the other areas free from accumulations of waste materials, rubbish and other debris resulting from the Work. At the completion of the Work CONTRACTOR shall remove all waste materials, rubbish and debris from Site and other areas as well as all tools, appliances, construction equipment and machinery and surplus materials. CONTRACTOR shall leave the Site clean and ready for utilization or occupancy by CITY at Substantial Completion of the Work. CONTRACTOR shall restore to all property not designated for alteration by the Contract Documents to its pre-Work condition.

E. CONTRACTOR shall not load nor permit any part of any structure to be loaded in any manner that will endanger the structure, nor shall CONTRACTOR subject any part of the Work or adjacent property to stresses or pressures that will endanger it.

6.13 Record Documents

A. CONTRACTOR shall maintain in a safe place at the Site one record copy of all Drawings, Specifications, Addenda, the Contract, Written Amendments, Change Orders, Work Change Directives, and written interpretations and clarifications in good order and annotated to show all changes made during construction. These record documents, together with all approved Samples and a counterpart of all approved Shop Drawings, will be available to CITY and DESIGN PROFESSIONAL for reference. Upon completion of the Work, these record documents, Samples and Shop Drawings will be delivered to DESIGN PROFESSIONAL for CITY.

6.14 Safety and Protection

A. CONTRACTOR shall be solely responsible for initiating, maintaining and supervising all safety precautions and programs in connection with the Work. CONTRACTOR shall comply with all applicable Laws or Regulations relating to the safety of persons or property to protect them from damage, injury or loss; and shall erect and maintain all necessary safeguards for safety and protection. CONTRACTOR shall deliver to CITY a copy of CONTRACTOR'S Health and Safety Plan as provided in the Notice of Intent to Contract.

B. CONTRACTOR shall notify owners of adjacent property and of Underground Facilities and other utility owners when prosecution of the Work may affect them, and shall cooperate with them in the protection, removal, relocation and replacement of their property. All damage, injury

or loss to any property referred to in Paragraph 6.14 B.2 or 6.14 B.3 caused, directly or indirectly, in whole or in part, by CONTRACTOR, any Subcontractor, Supplier or any other person or organization directly or indirectly employed by any of them to perform or furnish any of the Work or anyone for whose acts any of them may be liable, shall be remedied by CONTRACTOR (except damage or loss attributable to the fault of Drawings or Specifications or to the acts or omissions of CITY, DESIGN PROFESSIONAL, Consultant, or anyone employed by any of them or anyone for whose acts any of them may be liable, and not attributable, directly or indirectly, in whole or in part, to the fault or negligence of CONTRACTOR, Subcontractor, Supplier or other person or organization directly or indirectly employed by any of them). CONTRACTOR's duties and responsibilities for safety and for protection of the Work shall continue until such time as all the Work is completed and DESIGN PROFESSIONAL has issued a notice to CONTRACTOR in accordance with Paragraph 14.07 that the Work is acceptable (except as otherwise expressly provided in connection with Substantial Completion). CONTRACTOR shall take all necessary precautions for the safety of, and shall provide the necessary protection to prevent damage, injury or loss to:

1. all persons on the Site or who may be affected by the Work;
2. all the Work and materials and equipment to be incorporated therein, whether in storage on or off the Site; and
3. other property at the Site or adjacent thereto, including trees, shrubs, lawns, walks, pavements, roadways, structures, utilities and Underground Facilities not designated for removal, relocation or replacement in the course of the Work.

6.15 Safety Representative

A. In accordance with OSHA standards, CONTRACTOR shall designate a qualified and experienced safety representative whose duties and responsibilities shall be the prevention of accidents and the maintaining and supervising of safety precautions and programs. CONTRACTOR's safety representative shall remain at the Site whenever there is Work in progress and shall immediately notify CITY of any emergencies or accidents occurring at the Site

6.16 Hazard Communication Programs

A. CONTRACTOR shall be responsible for coordinating any exchange of material safety data sheets or other hazard communication information required to be made available to or exchanged between or among employers at the Site in accordance with Laws or Regulations.

6.17 Emergencies

A. In emergencies affecting the safety or protection of persons or the Work or property at the Site or adjacent thereto, CONTRACTOR, without special instruction or authorization from CITY or DESIGN PROFESSIONAL, is obligated to act to prevent threatened damage, injury or loss. CONTRACTOR shall give CITY and DESIGN PROFESSIONAL prompt written notice if CONTRACTOR believes that any significant changes in the Work or variations from the Contract Documents have been caused thereby or are required as a result thereof. If CITY determines that a change in the Contract Documents is required because of the action taken by CONTRACTOR in response to an emergency, a Work Change Directive or Change Order will be issued.

B. A change in the Contract Documents pursuant to Paragraph 6.15 A will not be an automatic authorization of, nor a condition precedent to, entitlement to adjustment in the Contract Price or Contract Times. If CITY and CONTRACTOR are unable to agree on entitlement to, or magnitude of, an equitable adjustment in the Contract Price or Contract Times, a Claim may be made therefore as provided in Article 16. However, OWNER, DESIGN PROFESSIONAL and Consultants shall not be liable to CONTRACTOR for any costs, losses or damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all other dispute resolution costs) sustained by CONTRACTOR on or in connection with any other project or anticipated project.

6.18 Shop Drawings and Samples

A. CONTRACTOR shall submit Shop Drawings to DESIGN PROFESSIONAL for review and approval in accordance with the accepted schedule of Shop Drawings and Sample submittals (see Paragraph 2.07). All submittals shall be identified as DESIGN PROFESSIONAL may require and in the number of copies specified in the General Requirements. The data shown on the Shop Drawings shall be complete with respect to quantities, dimensions, specified performance and design criteria, materials and similar data to show DESIGN PROFESSIONAL the services, materials and equipment CONTRACTOR proposes to provide and to enable DESIGN PROFESSIONAL to review the information for the limited purposes required by Paragraph 6.18 D.

B. CONTRACTOR shall also submit Samples to DESIGN PROFESSIONAL for review and approval in accordance with said accepted schedule of Shop Drawings and Sample submittals. Each Sample shall be identified clearly as to material, Supplier, pertinent data such as catalog numbers and the use for which intended and otherwise as DESIGN PROFESSIONAL may require to enable DESIGN PROFESSIONAL to review the submittal for the limited purposes required by Paragraph 6.18 D. The numbers of each Sample to be submitted will be as specified in the Specifications.

C. Submittal Procedures:

1. Before submitting each Shop Drawing or Sample, CONTRACTOR shall have determined and verified:

a. all field measurements, quantities, dimensions, specified performance criteria, installation requirements, materials, catalog numbers and similar information with respect thereto;

b. all materials with respect to intended use, fabrication, shipping, handling, storage, assembly and installation pertaining to the performance of the Work;

c. all information relative to means, methods, techniques, sequences and procedures of construction and safety precautions and programs incident thereto; and

d. CONTRACTOR shall also have reviewed and coordinated each Shop Drawing or Sample with other Shop Drawings and Samples and with the requirements of the Work and the Contract Documents.

2. Each submittal shall bear a stamp or specific written indication that CONTRACTOR has satisfied CONTRACTOR's obligations under the Contract Documents with respect to CONTRACTOR's review and approval of that submittal.

3. At the time of each submission, CONTRACTOR shall give DESIGN PROFESSIONAL specific written notice of such variations, if any, that the Shop Drawing or Sample submitted may have from the requirements of the Contract Documents, the notice to be in a written communication separate from the submittal, and, in addition, shall cause a specific notation to be made on each Shop Drawing and Sample submitted to DESIGN PROFESSIONAL for review and approval of each such variation.

D. DESIGN PROFESSIONAL's Review:

1. DESIGN PROFESSIONAL will review and approve Shop Drawings and Samples in accordance with the schedule of Shop Drawings and Sample submittals accepted by DESIGN PROFESSIONAL as required by Paragraph 2.06. DESIGN PROFESSIONAL's review and approval will be only to determine if the items covered by the submittals will, after installation or incorporation into the Work, conform to the information given in the Contract Documents and be compatible with the design concept of the completed Project as a functioning whole as indicated by the Contract Documents.

2. DESIGN PROFESSIONAL's review and approval will not extend to means, methods, techniques, sequences or procedures of construction (except where a particular means,

method, technique, sequence or procedure of construction is specifically and expressly called for by the Contract Documents) or to safety precautions or programs incident thereto. The review and approval of a separate item as such will not indicate approval of the assembly in which the item functions.

3. DESIGN PROFESSIONAL's review and approval of Shop Drawings or Samples shall not relieve CONTRACTOR from responsibility for any variation from the requirements of the Contract Documents unless CONTRACTOR has in writing called DESIGN PROFESSIONAL's attention to each such variation at the time of submission as required by Paragraph 6.18 C.3, and DESIGN PROFESSIONAL has given written approval of each such variation by specific written notation thereof incorporated into or accompanying the Shop Drawing or Sample approval; nor will any approval by DESIGN PROFESSIONAL relieve CONTRACTOR from responsibility for complying with the requirements of Paragraph 6.18 C.1.

E. Where a Shop Drawing or Sample is required by the Contract Documents or the schedule of Shop Drawings and Sample submissions accepted by DESIGN PROFESSIONAL as required by Paragraph 2.06, any related Work performed prior to DESIGN PROFESSIONAL's review and approval of the pertinent submittal will be at the sole expense and responsibility of CONTRACTOR.

F. CONTRACTOR shall make corrections required by DESIGN PROFESSIONAL and shall return the required number of corrected copies of Shop Drawings and submit as required new Samples for review and approval. CONTRACTOR shall direct specific attention in writing to revisions other than the corrections called for by DESIGN PROFESSIONAL on previous submittals.

6.19 Continuing the Work

A. CONTRACTOR shall carry on the Work and adhere to the progress schedule during all disputes or disagreements with CITY. No Work shall be delayed or postponed pending resolution of any disputes or disagreements, except as permitted by Paragraph 15.04 or as CITY and CONTRACTOR may otherwise agree in writing.

6.20 CONTRACTOR's General Warranty and Guarantee

A. CONTRACTOR warrants and guarantees to CITY, DESIGN PROFESSIONAL and Consultants that all Work will be in accordance with the Contract Documents and will not be defective. CONTRACTOR's warranty and guarantee hereunder excludes defects or damage caused by:

1. abuse, modification or improper maintenance or operation by persons other than CONTRACTOR, Subcontractors, Suppliers or any other individual or entity for whom CONTRACTOR is responsible; or
2. normal wear and tear under normal usage.

B. CONTRACTOR's obligation to perform and complete the Work in accordance with the Contract Documents shall be absolute. None of the following will constitute an acceptance of Work that is not in accordance with the Contract Documents or a release of CONTRACTOR's obligation to perform the Work in accordance with the Contract Documents:

1. observations by DESIGN PROFESSIONAL;
2. recommendation of any progress or final payment by DESIGN PROFESSIONAL;
3. the issuance of a certificate of Substantial Completion or any payment related thereto by CITY to CONTRACTOR;
4. use or occupancy of the Work or any part thereof by OWNER;
5. any review and approval of a Shop Drawing or Sample submittal or the issuance of a notice of acceptability by DESIGN PROFESSIONAL;

6. any inspection, test or approval by others; or
7. any correction of defective Work by CITY.

C. Nonconforming Work is rejected unless expressly accepted in writing by the CITY's Representative.

ARTICLE 7 OTHER WORK

7.01 Related Work at Site

A. CITY may perform other work related to the Project at the Site by CITY's own forces, or let other direct contracts therefore, or have other work performed by utility owners. If such other work is to be performed and such fact was not noted in the Contract Documents, then:

1. Written notice thereof will be given to CONTRACTOR prior to starting any such other work, and

2. CONTRACTOR may make a Claim therefore as provided in Article 16 if CONTRACTOR believes that such performance involves additional expense to CONTRACTOR or requires additional time and the parties are unable to agree as to the amount or extent thereof.

B. CONTRACTOR shall afford each other contractor who is a party to such a direct contract, and each utility owner (and CITY, if CITY is performing the additional work with CITY's employees) proper and safe access to the Site and a reasonable opportunity for the introduction and storage of materials and equipment and the execution of such other work and shall properly connect and coordinate the Work with theirs. Unless otherwise provided in the Contract Documents, CONTRACTOR shall do all cutting, fitting and patching of the Work that may be required to properly connect or otherwise make its several parts come together and properly integrate with such other work. CONTRACTOR shall not endanger any work of others by cutting, excavating or otherwise altering their work and will only cut or alter their work with the written consent of CITY and the others whose work will be affected. The duties and responsibilities of CONTRACTOR under this Paragraph are for the benefit of such utility owners and other contractors to the extent that there are comparable provisions for the benefit of CONTRACTOR in said direct contracts between CITY and such utility owners and other contractors.

C. If the proper execution or results of any part of CONTRACTOR's Work depends upon work performed by others under this Article 7, CONTRACTOR shall inspect such other work and promptly report to CITY and DESIGN PROFESSIONAL in writing any delays, defects or deficiencies in such other work that render it unavailable or unsuitable for the proper execution or results of CONTRACTOR's Work. CONTRACTOR's failure to report same will constitute an acceptance of such other work as fit and proper for integration with CONTRACTOR's Work, except for latent or non-apparent defects and deficiencies in such other work.

7.02 Coordination

A. If CITY contracts with others for the performance of other work on the Project at the Site, the following will be set forth in Supplementary Conditions:

1. the person, firm or corporation who will have authority and responsibility for coordination of the activities among the various prime contractors will be identified;
2. the specific matters to be covered by such authority and responsibility will be itemized; and
3. the extent of such authority and responsibilities will be provided.

B. Unless otherwise provided in the Supplementary Conditions, CITY shall have sole authority and responsibility in respect of such coordination.

ARTICLE 8 CITY'S RESPONSIBILITIES

8.01 Communications to CONTRACTOR

A. Except as otherwise provided in these General Conditions, CITY shall issue all communications to CONTRACTOR.

8.02 Replacement of DESIGN PROFESSIONAL

A. In case of termination of the employment of DESIGN PROFESSIONAL, CITY shall appoint a DESIGN PROFESSIONAL whose status under the Contract Documents shall be that of the former DESIGN PROFESSIONAL.

8.03 Furnish Data and Prompt Payment

A. CITY shall promptly furnish the data required of OWNER under the Contract Documents and shall make payments to CONTRACTOR when they are due.

8.04 Lands and Easements; Reports and Tests

A. CITY's duties in respect of providing lands and easements and providing engineering surveys to establish reference points are set forth in Paragraphs 4.01 and 4.05. Paragraph 4.02 refers to CITY's duty to identify and make available to CONTRACTOR copies of reports of explorations and tests of subsurface conditions at the Site and drawings of physical conditions in existing structures at or contiguous to the Site that have been utilized by DESIGN PROFESSIONAL in preparing the Contract Documents.

8.05 Insurance

A. CITY's responsibilities, if any, for purchasing and maintaining liability and property insurance are set forth in Article 5 and the Supplementary Conditions.

8.06 Change Orders

A. CITY is obligated to execute Change Orders as indicated in Paragraph 10.03.

8.07 Inspections, Tests and Approvals

A. CITY's responsibility for certain inspections, tests and approvals is set forth in Paragraph 13.02 F.

8.08 Limitations on CITY's Responsibilities

A. The CITY shall not supervise, direct or have control or authority over, nor be responsible for, CONTRACTOR's means, methods, techniques, sequences or procedures of construction, or the safety precautions and programs incident thereto, or for any failure of CONTRACTOR to comply with Laws or Regulations applicable to the furnishing or performance of the Work. CITY will not be responsible for CONTRACTOR's failure to perform or furnish the Work in accordance with the Contract Documents.

8.09 Undisclosed Hazardous Environmental Condition

A. CITY's responsibility for an undisclosed Hazardous Environmental Condition uncovered or revealed at the Site is set forth in Paragraph 4.06.

8.10 Evidence of Financial Arrangements

A. CITY will furnish CONTRACTOR reasonable evidence that financial arrangements have been made to satisfy OWNER's obligations under the Contract.

8.11 CITY's Representative

A. CITY will provide a representative during the construction period. The duties, responsibilities and the limitations of authority of the CITY "s Representative during construction are set forth in the Contract Documents.

8.12 Visits to Site

A. CITY's Representative will make visits to the Site at intervals appropriate to the various stages of construction as CITY's Representative deems necessary in order to observe the progress that has been made and the quality of the various aspects of CONTRACTOR's executed Work. Based on information obtained during such visits and observations, CITY's Representative will endeavor to determine, in general, if the Work is proceeding in accordance with the Contract Documents. CITY's Representative will not be required to make exhaustive or continuous on-Site inspections to check the quality or quantity of the Work.

ARTICLE 9 DESIGN PROFESSIONAL's STATUS DURING CONSTRUCTION

9.01 General Scope of DESIGN PROFESSIONAL's Duties

A. DESIGN PROFESSIONAL's efforts will be directed toward providing for CITY a greater degree of confidence that the completed Work will conform generally to the Contract Documents. On the basis of visits to the Site and on-Site observations, DESIGN PROFESSIONAL will keep CITY informed of the progress of the Work and will endeavor to guard CITY against defective Work. DESIGN PROFESSIONAL's visits to the Site and on-Site observations are subject to all the limitations on DESIGN PROFESSIONAL's authority and responsibility set forth in Paragraph 9.08.

9.02 Resident Project Representative

A. If CITY and DESIGN PROFESSIONAL agree, DESIGN PROFESSIONAL will furnish a resident Project representative to assist DESIGN PROFESSIONAL in providing more extensive observation of the Work. The responsibilities, authority and limitations thereon of any such resident Project representative and assistants will be as provided in Paragraph 9.08 and in the Supplementary Conditions.

9.03 Clarifications and Interpretations

A. DESIGN PROFESSIONAL will issue with reasonable promptness written clarifications or interpretations (which may be in the form of Drawings) of the requirements of the Drawings and Specifications prepared by the DESIGN PROFESSIONAL as DESIGN PROFESSIONAL may determine necessary, which shall be consistent with the intent of and reasonably inferable from the Contract Documents. Such written clarifications and interpretations will be binding on CITY and CONTRACTOR. If CITY or CONTRACTOR believes that a written clarification or interpretation justifies an adjustment in the Contract Price pursuant to Article 11 and/ or the Contract Times pursuant to Article 12 and the parties are unable to agree to the amount or extent thereof, if any, a Claim may be made therefore as provided in Article 16.

9.04 Rejecting Defective Work

A. DESIGN PROFESSIONAL will have authority to disapprove or reject Work which DESIGN PROFESSIONAL believes to be defective, that DESIGN PROFESSIONAL believes will not produce a completed Project that conforms to the Contract Documents, or that will prejudice the integrity of the design concept of the completed Project as a functioning whole as indicated by the Contract Documents. DESIGN PROFESSIONAL will also have authority to require special inspection or testing of the Work as provided in Paragraph 13.04 B, whether or not the Work is fabricated, installed or completed.

9.05 Shop Drawings, Change Orders and Payments

A. In connection with DESIGN PROFESSIONAL's authority as to Shop Drawings and Samples, see Paragraph 6.18.

B. In connection with DESIGN PROFESSIONAL's authority as to Change Orders, see Article 10.

C. In connection with DESIGN PROFESSIONAL's authority as to Applications for Payment, see Article 14.

9.06 Determinations for Unit Prices

A. DESIGN PROFESSIONAL will initially determine the actual quantities and classifications of Unit Price Work performed by CONTRACTOR. DESIGN PROFESSIONAL will review with CONTRACTOR the DESIGN PROFESSIONAL's preliminary determinations on such matters before rendering a written opinion thereon (by recommendation of an Application for Payment or otherwise to the CITY). CITY reserves the right to make a final determination of the actual quantities and classifications of Unit Price Work in reviewing an Application for Payment. Within ten (10) days after the date of receipt of any such decision, CONTRACTOR may deliver to CITY and to DESIGN PROFESSIONAL written notice of intention to appeal CITY's decision pursuant to Article 16.

9.07 Decisions on Requirements of Contract Documents and Acceptability of Work

A. DESIGN PROFESSIONAL will be the initial interpreter of the requirements of the Drawings and Specifications prepared by DESIGN PROFESSIONAL and judge of the acceptability of the Work thereunder.

B. When functioning as interpreter and judge under this Paragraph 9.07, DESIGN PROFESSIONAL will not show partiality to OWNER or CONTRACTOR.

C. Claims, disputes and other matters relating to the acceptability of the Work, quantities and classifications of Unit Price Work, or the interpretation of the requirements of the Contract Documents pertaining to the performance and furnishing of the Work will be referred initially to CITY's Representative in writing with a request for a formal decision in accordance with Article 16.

9.08 Limitations on DESIGN PROFESSIONAL's Authority and Responsibilities

A. Neither DESIGN PROFESSIONAL's authority or responsibility under this Article 9 or under any other provision of the Contract Documents nor any decision made by DESIGN PROFESSIONAL in good faith either to exercise or not exercise such authority or responsibility or the undertaking, exercise or performance of any authority or responsibility by DESIGN PROFESSIONAL shall create, impose or give rise to any duty owed by DESIGN PROFESSIONAL to CONTRACTOR, any Subcontractor, any Supplier, any other person or organization, or to any surety for or employee or agent of any of them.

B. DESIGN PROFESSIONAL will not supervise, direct, control or have authority over or be responsible for CONTRACTOR's means, methods, techniques, sequences or procedures of construction, or the safety precautions and programs incident thereto, or for any failure of CONTRACTOR to comply with Laws or Regulations applicable to the furnishing or performance of the Work. DESIGN PROFESSIONAL will not be responsible for CONTRACTOR's failure to perform or furnish the Work in accordance with the Contract Documents.

C. DESIGN PROFESSIONAL will not be responsible for the acts or omissions of CONTRACTOR or of any Subcontractor, any Supplier, or of any other person or organization performing or furnishing any of the Work.

D. DESIGN PROFESSIONAL's review of the final Application for Payment and accompanying documentation, and all maintenance and operating instructions, schedules, guarantees, Bonds and certificates of inspection, tests and approvals and other documentation required to be delivered by Paragraph 14.07 will only be to determine generally that their content complies with the requirements of, and in the case of certificates of inspections, tests and approvals, that the results certified indicate compliance with, the Contract Documents.

E. The limitations upon authority and responsibility set forth in this Paragraph 9.08 shall also apply to DESIGN PROFESSIONAL's Consultants, resident Project representative and assistants as identified in the Supplementary Conditions.

ARTICLE 10 CHANGES IN THE WORK

10.01 Authorized Changes in the Work

A. Without invalidating the Contract and without notice to any surety, CITY may, at any time or from time to time, order additions, deletions or revisions in the Work. Such additions, deletions or revisions will be authorized by a Written Amendment, a Change Order, or a Work Change Directive. Upon receipt of any such document, CONTRACTOR shall promptly proceed with the Work involved that will be performed under the applicable conditions of the Contract Documents (except as otherwise specifically provided).

B. If CITY and CONTRACTOR are unable to agree on entitlement to, or on the amount or extent, if any, of an adjustment in the Contract Price pursuant to Article 11 or an adjustment of the Contract Times pursuant to Article 12 or both that should be allowed as a result of a Work Change Directive, a Claim may be made therefore as provided in Article 16.

10.02 Unauthorized Changes in the Work

A. CONTRACTOR shall not be entitled to an increase in the Contract Price or an extension of the Contract Times with respect to any work performed that is not required by the Contract Documents as amended, modified or supplemented as provided in Paragraph 3.04, except in the case of an emergency as provided in Paragraph 6.17 or in the case of uncovering Work as provided in Paragraph 13.04.

10.03 Signing of Change Orders

A. CITY and CONTRACTOR, and DESIGN PROFESSIONAL shall sign appropriate Change Orders covering:

1. changes in the Work which are:
 - a. ordered by CITY pursuant to Paragraph 10.01 A; or
 - b. required because of acceptance of defective Work under Paragraph 13.08 or correcting defective Work under Paragraph 13.09; or
 - c. agreed to by the parties;
2. changes in the Contract Price or Contract Times or both which are agreed to by the parties, including any undisputed sum or amount of time for Work actually performed in accordance with a Work Change Directive; and
3. changes in the Contract Price or Contract Times or both which embody the substance of any written decision recommended by DESIGN PROFESSIONAL and approved by CITY pursuant to Paragraph 9.06, provided that, in lieu of signing any such Change Order, an appeal may be taken from any such decision in accordance with the provisions of the Contract Documents and applicable Laws or Regulations, but during any such appeal, CONTRACTOR shall carry on the Work and adhere to the progress schedule as provided in Paragraph 6.19.

10.04 Notification to Surety

A. If notice of any change affecting the general scope of the Work or the provisions of the Contract Documents (including, but not limited to, Contract Price or Contract Times or both) is required by the provisions of any Bond to be given to a surety, the giving of any such notice will be CONTRACTOR's responsibility, and the amount of each applicable Bond will be adjusted accordingly.

ARTICLE 11 CHANGE OF CONTRACT PRICE

11.01 Change of Contract Price

A. The Contract Price constitutes the total compensation (subject to authorized adjustments) payable to CONTRACTOR for performing the Work. All duties, responsibilities and obligations assigned to or undertaken by CONTRACTOR shall be at CONTRACTOR's expense without change in the Contract Price.

B. The Contract Price may only be changed by a Change Order. Any request for an adjustment in the Contract Price shall be based on written notice delivered within fourteen (14) calendar days after occurrence of the event giving rise to the request or within fourteen (14) calendar days after first recognition of the conditions giving rise to the request. Prior notice is not required for requests or claims relating to an emergency endangering life or property as described in Paragraph 6.16. Thereafter, the CONTRACTOR shall submit written documentation of its request, including appropriate supporting documentation, within ten (10) calendar days after giving notice, unless the CITY grants an extension based on good cause shown by the CONTRACTOR that such additional time is warranted.

C. The value of any Work covered by a Change Order or of any request for an adjustment in the Contract Price will be determined as follows:

1. where the Work involved is covered by Unit Prices contained in the Contract Documents, by application of such Unit Prices to the quantities of the items involved (subject to the provisions of Paragraph 11.04); or

2. where the Work involved is not covered by Unit Prices contained in the Contract Documents, by a mutually agreed lump sum; or

3. where the Work involved is not covered by Unit Prices contained in the Contract Documents and agreement to a lump sum is not reached under Paragraph 11.01 C.2, on the basis of the Cost of the Work (determined as provided in Paragraphs 11.02 A and B) plus a CONTRACTOR's fee for overhead and profit (determined as provided in Paragraph 11.01 D).

D. The CONTRACTOR's fee allowed to CONTRACTOR for overhead and profit shall be determined as follows:

1. a mutually acceptable fixed fee; or

2. if a fixed fee is not agreed upon, then a fee based on the following percentages of the various portions of the Cost of the Work:

a. for costs incurred under Paragraphs 11.02 A.1 and 11.02 A.2, the CONTRACTOR's fee shall be ten percent (10%);

b. for costs incurred under Paragraph 11.02 A.3, the CONTRACTOR's fee shall be five percent (5%);

c. where one or more tiers of subcontracts are on the basis of the Cost of the Work plus a fee and no fixed fee is agreed upon, the intent of Paragraphs 11.01 D.2 and 11.02 A.1 through A.3 is that the Subcontractor who actually performs or furnishes the Work, at whatever tier, will be paid a fee of ten percent (10%) of the costs incurred by such Subcontractor under Paragraphs 11.02 A.1 and 11.02 A.2 and that any higher tier Subcontractor and CONTRACTOR will each be paid a fee of five percent (5%) of the amount paid to the next lower tier Subcontractor;

d. no fee shall be payable on the basis of costs itemized under Paragraphs 11.02 A.4, 11.02 A.5 and 11.02 B;

e. the amount of credit to be allowed by CONTRACTOR to CITY for any change which results in a net decrease in cost will be the amount of the actual net decrease in costs plus a deduction in CONTRACTOR's fee by an amount equal to five percent (5%) of such net decrease; and

f. when both additions and credits are involved in any one change, the adjustment in CONTRACTOR's fee shall be computed on the basis of the net change in accordance with Paragraphs 11.01 D.2.a through 11.01 D.2.e, inclusive.

E. Whenever the Cost of the Work is to be determined pursuant to Paragraphs 11.02 A and B, CONTRACTOR shall establish and maintain records thereof in accordance with generally

accepted accounting practices and submit in form acceptable to CITY an itemized cost breakdown together with supporting data.

11.02 Cost of the Work

A. The term “Cost of the Work” means the sum of all costs necessarily incurred and paid by CONTRACTOR in the proper performance of the Work. When the value of any Work covered by a Change Order or when a request for an adjustment in Contract Price is determined on the basis of Cost of the Work, the costs to be reimbursed to CONTRACTOR will be only those additional or incremental costs required because of the change in the Work or because of the event giving rise to the request. Except as otherwise agreed to in writing by CITY, costs covered by Change Orders or requests shall be in amounts no higher than those prevailing in the locality of the Project, shall include only the following items and shall not include any costs itemized in 11.02 B:

1. Payroll costs for employees in the direct employ of CONTRACTOR in the performance of the Work, using occupational titles and job classifications agreed upon by CITY and CONTRACTOR. Such employees shall include, without limitation, job Site superintendents, foremen and other personnel employed full time at the Site. Payroll costs for employees not employed full time on the Work shall be apportioned on the basis of their time spent on the Work. Payroll costs shall include, but not be limited to, salaries and wages plus the cost of fringe benefits which shall include social security contributions, unemployment, excise and payroll taxes, workers’ compensation, health and retirement benefits, bonuses, sick leave, vacation and holiday pay applicable thereto. The expenses of performing the Work after regular working hours, on Saturdays, Sundays or legal holidays, shall be included in the above to the extent authorized by OWNER.

2. Cost of all materials and equipment furnished and incorporated into the Work, including costs of transportation and storage thereof, and Suppliers’ field services required in connection therewith. All cash discounts shall accrue to CONTRACTOR unless CITY deposits funds with CONTRACTOR with which to make payments, in which case the cash discounts shall accrue to CITY. All trade discounts, rebates and refunds and returns from sale of surplus materials and equipment shall accrue to CITY, and CONTRACTOR shall make provisions so that they may be obtained.

3. Payments made by CONTRACTOR to Subcontractors for Work performed or furnished by Subcontractors. If required by CITY, CONTRACTOR shall obtain competitive bids from Subcontractors acceptable to OWNER and CONTRACTOR and shall deliver such bids to CITY who will then determine, with the advice of DESIGN PROFESSIONAL, which bids, if any, will be accepted. If any subcontract provides that the Subcontractor is to be paid on the basis of the Cost of the Work plus a fee, the Subcontractor’s Cost of the Work and fee shall be determined in the same manner as CONTRACTOR’s Cost of the Work and fee as provided in Paragraphs 11.01 D and E and 11.02 A and B. All subcontracts shall be subject to the other provisions of the Contract Documents insofar as applicable.

4. Costs of special consultants (including but not limited to engineers, architects, testing laboratories, surveyors, attorneys and accountants) employed for services specifically related to the Work when such services are approved in advance by CITY in writing.

5. Other costs including the following:

a. The proportion of necessary transportation, travel and subsistence expenses of CONTRACTOR’s employees incurred in discharge of duties connected with the Work.

b. Cost, including transportation and maintenance, of all materials, supplies, equipment, machinery, appliances, office and temporary facilities at the Site and hand tools not owned by the workers, which are consumed in the performance of the Work, and cost, less market value of such items used but not consumed which remain the property of CONTRACTOR.

c. Rentals of all construction equipment and machinery and the parts thereof whether rented from CONTRACTOR or others in accordance with rental agreements approved by CITY with the advice of DESIGN PROFESSIONAL, and the costs of transportation, loading, unloading, installation, assembly, dismantling and removal thereof, all in accordance with the terms of said rental agreements. The rental of any such equipment, machinery or parts shall cease when the use thereof is no longer necessary for the Work.

d. Applicable sales, consumer, use or similar taxes related to the Work, and for which CONTRACTOR is liable, imposed by Laws or Regulations.

e. Deposits lost for causes other than negligence of CONTRACTOR, any Subcontractor or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable, and royalty payments and fees for permits and licenses required to perform the Work.

f. Losses and damages (and related expenses) caused by damage to the Work, not compensated by insurance or otherwise, sustained by CONTRACTOR in connection with the performance and furnishing of the Work (except losses and damages within the deductible amounts of property insurance established by CITY in accordance with Article 5), provided they have resulted from causes other than the negligence of CONTRACTOR, any Subcontractor, or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable. Such losses shall include settlements made with the written consent and approval of CITY. No such losses, damages and expenses shall be included in the Cost of the Work for the purpose of determining CONTRACTOR's fee. If, however, any such loss or damage requires reconstruction and CONTRACTOR is placed in charge thereof, CONTRACTOR shall be paid for those services a fee proportionate to that stated in Paragraph 11.01 D.2.

g. The cost of utilities, fuel and sanitary facilities at the Site.

h. Minor expenses such as telegrams, long distance telephone calls, telephone service at the Site, expressage and similar petty cash items in connection with the Work.

i. Cost of premiums for additional or increased Bonds, or for insurance required because of approved changes in the Work.

B. Costs excluded: The term "Cost of the Work" shall not include any of the following:

1. Payroll costs and other compensation of CONTRACTOR's officers, executives, principals (of partnership and sole proprietorships), general managers, engineers, architects, estimators, attorneys, auditors, accountants, purchasing and contracting agents, expeditors, timekeepers, clerks and other personnel employed by CONTRACTOR whether at the Site or in CONTRACTOR's principal or a branch office for general administration of the Work (if not specifically included in the agreed upon occupational titles and job classifications referred to in Paragraph 11.02 A.1 or specifically covered by Paragraph 11.02 A.4), all of which are to be considered administrative costs covered by the CONTRACTOR's fee.

2. Expenses of CONTRACTOR's principal and branch offices other than CONTRACTOR's office at the Site.

3. Any part of CONTRACTOR's capital expenses, including interest on CONTRACTOR's capital employed for the Work and charges against CONTRACTOR for delinquent payments.

4. Costs due to the negligence of CONTRACTOR, any Subcontractor, or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable, including but not limited to, the correction of defective Work, disposal of materials, or equipment wrongly supplied, and making good any damage to property.

5. Other overhead or general expense costs of any kind and the costs of any item not specifically and expressly included in Paragraph 11.02 A.

11.03 Cash Allowances

A. It is understood that CONTRACTOR has included in the Contract Price all allowances so named in the Contract Documents and shall cause the Work so covered to be furnished and performed for such sums as may be acceptable to CITY. CONTRACTOR agrees that:

1. the allowances include the cost to CONTRACTOR (less any applicable trade discounts) of materials and equipment required by the allowances to be delivered at the Site, and all applicable taxes; and

2. CONTRACTOR's costs for unloading and handling on the Site, labor, installation costs, overhead, profit and other expenses contemplated for the allowances have been included in the Contract Price and not in the allowances, and no demand for additional payment on account of any of the foregoing will be valid.

B. Prior to final payment, an appropriate Change Order will be issued by CITY to reflect actual amounts due CONTRACTOR on account of Work covered by allowances, and the Contract Price shall be correspondingly adjusted.

11.04 Unit Price Work

A. Where the Contract Documents provide that all or part of the Work is to be Unit Price Work, initially the Contract Price will be deemed to include for all Unit Price Work an amount equal to the sum of the established unit price for each separately identified item of Unit Price Work times the estimated quantity of each item as indicated in the Contract. The estimated quantities of items of Unit Price Work are not guaranteed and are solely for the purpose of comparison of Bids and determining an initial Contract Price. Determinations of the actual quantities and classifications of Unit Price Work performed by CONTRACTOR will be made in accordance with Paragraph 9.06.

B. Each unit price will be deemed to include an amount considered by CONTRACTOR to be adequate to cover CONTRACTOR's overhead and profit for each separately identified item.

C. CITY or CONTRACTOR may negotiate an adjustment of the price per unit of Unit Price Work stated in the Contract if:

1. the quantity of any item of Unit Price Work performed by CONTRACTOR differs by twenty percent (20%) or more from the estimated quantity of such item indicated in the Contract; and

2. there is no corresponding adjustment with respect to any other item of Work; and

3. CONTRACTOR believes that CONTRACTOR is entitled to an increase in Contract Price as a result of having incurred additional expense or CITY believes that CITY is entitled to a decrease in Contract Price.

11.05 Dispute Resolution

A. If CITY and CONTRACTOR are unable to agree on entitlement to, or magnitude of, an equitable adjustment in the Contract Price in accordance with Article 11 within fourteen (14) calendar days from the receipt of supporting documentation of the request pursuant to 11.01.B., unless the CITY grants an extension based on good cause shown by the CONTRACTOR that such additional time is warranted, then a Claim for such adjustment may be made pursuant to Article 16.

ARTICLE 12 CONTRACT TIMES

12.01 Time of the Essence

A. All times stated in the Contract Documents are of the essence of the Contract.

12.02 Change of Contract Times

A. The Contract Times (or Milestones) may only be changed by a Change Order. Any request for an adjustment in the Contract Times shall be based on written notice delivered within fourteen (14) calendar days after occurrence of the event giving rise to the request or within fourteen (14) calendar days after first recognition of the conditions giving rise to the request. Thereafter, the CONTRACTOR shall submit written documentation of its requests, including appropriate supporting documentation, within ten (10) days after giving notice, unless the CITY grants an extension based on good cause shown by the CONTRACTOR that such additional time is warranted.

12.03 Proof Required To Justify an Extension of Time For Excusable and Compensable Delays

A. In support of any request for an extension of the Contract Times pursuant to this Article, CONTRACTOR must demonstrate to the reasonable satisfaction of the CITY that the critical path of the approved baseline project schedule was delayed. CONTRACTOR shall be entitled to an increase in contract time for the number of days that the critical path was delayed solely as a result of the compensable or excusable event. A compensable or excusable event includes, but is not limited to:

1. unreasonable delay of issuance of Notice to Proceed by CITY;
2. CITY's unreasonable delay of delivery furnished materials, equipment, or work;
3. unreasonable delay responding to shop drawings and submittals;
4. CITY's unreasonable delay in issuing a Change Order;
5. an order by the CITY to stop the Work where the CONTRACTOR was not at fault;
and
6. other reasonable grounds as determined by the City in its sole discretion.

B. CONTRACTOR shall compare the critical path of the approved baseline project schedule to the actual critical path of the Work, identifying the specific impact of the compensable or excusable event.

C. CONTRACTOR shall submit to the CITY a written time impact analysis illustrating the influence of each compensable or excusable event on the date of Substantial Completion. The time impact analysis shall demonstrate the time impact based on the date of the delay in time and the event time computations or all affected activities.

D. If the critical path of the Work is delayed by "Force Majeure", the CONTRACTOR shall be entitled only to an extension of the Contract Times for the number of days of delay to the critical path. For purposes of this paragraph, "Force Majeure" shall mean fire, tornado, flood, earthquake, war, act of terrorism, civil disturbance, or labor strikes away from the project site.

E. Extensions of contract time pursuant to the this section will be granted only to the extent that the time adjustments exceed the total float time available when the event causing the delay occurred.

12.04 Delays Within CONTRACTOR's Control

A. The Contract Times (or Milestones) will not be extended due to delays within the control of CONTRACTOR. Delays attributable to and within the control of a Subcontractor or Supplier shall be deemed to be delays within the control of CONTRACTOR.

12.05 Delays Beyond the CITY's and CONTRACTOR's Control

A. Where CONTRACTOR is prevented from completing any part of the Work within the Contract Times (or Milestones) due to delay beyond the control of both CITY and CONTRACTOR, an extension of the Contract Times (or Milestones) in an amount equal to the time lost due to such delay shall be CONTRACTOR's sole and exclusive remedy for such delay.

12.06 Delay Damages

A. In no event shall CITY be liable to CONTRACTOR, any Subcontractor, any Supplier, any other person or organization, or to any surety for or employee or agent of any of them, for damages arising out of or resulting from:

1. delays caused by or within the control of CONTRACTOR, or

2. delays beyond the control of CITY or CONTRACTOR including but not limited to fires, floods, epidemics, abnormal weather conditions, acts of God or acts or neglect by utility owners or other contractors performing other work as contemplated by Article 7.

B. Nothing in this Paragraph 12.06 bars a change in Contract Price pursuant to this Article 12 to compensate CONTRACTOR due to delay, interference, or disruption directly attributable to actions or inaction of CITY, DESIGN PROFESSIONAL, Consultant or anyone for whom CITY, DESIGN PROFESSIONAL or Consultant is responsible.

12.07 Dispute Resolution

A. If CITY and CONTRACTOR are unable to agree on entitlement to, or magnitude of, an equitable adjustment in the Contract Time in accordance with Article 12 within fourteen (14) calendar days from the receipt of supporting documentation of the request pursuant to 12.02, unless the CITY grants an extension based on good cause shown by the CONTRACTOR that such additional time is warranted, then a Claim for such adjustment may be made pursuant to Article 16.

ARTICLE 13 TESTS AND INSPECTIONS; CORRECTION, REMOVAL OR ACCEPTANCE OF DEFECTIVE WORK

13.01 Access to Work

A. CITY, DESIGN PROFESSIONAL, Consultants, other representatives and personnel of CITY, independent testing laboratories and governmental agencies with jurisdictional interests will have access to the Site and Work at reasonable times for their observation, inspecting and testing. CONTRACTOR shall provide them proper and safe conditions for such access and advise them of CONTRACTOR's Site safety procedures and programs so that they may comply therewith as applicable.

13.02 Tests and Inspections

A. CONTRACTOR shall give DESIGN PROFESSIONAL and CITY's Representative timely notice of readiness of the Work for all required inspections, tests or approvals, and shall cooperate with inspection and testing personnel to facilitate required inspections or tests.

B. If any Work (or the work of others at the Site) that is to be inspected, tested or approved is covered by CONTRACTOR without written approval required by Paragraphs 13.02 D or 13.02 E, it must, if requested by CITY's Representative, be uncovered for observation.

C. Uncovering Work as provided in Paragraph 13.02 B, shall be at CONTRACTOR's expense unless CONTRACTOR has given DESIGN PROFESSIONAL and CITY's Representative timely notice of CONTRACTOR's intention to cover the same and DESIGN PROFESSIONAL and CITY's Representative have not acted with reasonable promptness in response to such notice.

D. If Laws or Regulations of any public body (including City) having jurisdiction require any Work (or part thereof) specifically to be inspected, tested or approved by an employee or other representative of such public body, CONTRACTOR shall assume full responsibility for arranging and obtaining such inspections, tests or approvals, pay all costs in connection therewith, and furnish DESIGN PROFESSIONAL and CITY's Representative the required certificates of inspection or approval.

E. CONTRACTOR shall be responsible for arranging and obtaining and shall pay all costs in connection with any inspections, tests or approvals required for CITY's and DESIGN

PROFESSIONAL's acceptance of materials or equipment to be incorporated into the Work, or acceptance of materials, mix designs, or equipment submitted for approval prior to CONTRACTOR's purchase thereof for incorporation into the Work. Such inspections, tests, or approvals shall be performed by organizations acceptable to CITY and DESIGN PROFESSIONAL.

F. CITY shall employ and pay for the services of an independent testing laboratory to perform all inspections, tests, or approvals required by the Contract Documents except:

1. for inspections, tests or approvals covered by Paragraph 13.02 D and E;
2. that costs incurred in connection with tests or inspections conducted pursuant to Paragraph 13.04 B shall be paid as provided in said Paragraph 13.04 B; and
3. as otherwise specifically provided in the Contract Documents.

13.03 Notice of Defects

A. Prompt notice of all defective Work of which either CITY or DESIGN PROFESSIONAL has actual knowledge will be given to CONTRACTOR. Defective Work may be rejected, corrected or accepted as provided in this Article 13.

13.04 Uncovering Work

A. If any Work (or the work of others at the Site) is covered contrary to the written request of DESIGN PROFESSIONAL or CITY's Representative, it must, if requested by CITY's Representative, be uncovered for DESIGN PROFESSIONAL's or CITY's Representative's observation and replaced at CONTRACTOR's expense.

B. If CITY considers it necessary or advisable that covered Work be observed by DESIGN PROFESSIONAL or CITY's Representative or be inspected or tested by others, CONTRACTOR, at CITY's request, shall uncover, expose or otherwise make available for observation, inspection or testing as may be required, that portion of the Work in question, furnishing all necessary labor, material and equipment. If it is found that such Work is defective, CONTRACTOR shall pay all costs, losses and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) caused by, arising out of or resulting from such uncovering, exposure, observation, inspection and testing and of satisfactory replacement or reconstruction (including but not limited to all costs of repair or replacement of work of others); and CITY shall be entitled to an appropriate decrease in the Contract Price. If the parties are unable to agree as to the amount thereof, CITY may make a Claim therefore as provided in Article 16. If, however, such Work is not found to be defective, CONTRACTOR shall be allowed an increase in the Contract Price or an extension of the Contract Times (or Milestones), or both, directly attributable to such uncovering, exposure, observation, inspection, testing, replacement and reconstruction. If the parties are unable to agree as to the amount or extent thereof, CONTRACTOR may make a Claim therefore as provided in Article 16.

13.05 CITY May Stop the Work

A. If the Work is defective, or CONTRACTOR fails to supply sufficient skilled workers or suitable materials or equipment, or fails to furnish or perform the Work in such a way that the completed Work will conform to the Contract Documents, CITY may order CONTRACTOR to stop the Work, or any portion thereof, until the cause for such order has been eliminated; however, this right of CITY to stop the Work shall not give rise to any duty on the part of CITY to exercise this right for the benefit of CONTRACTOR, any Subcontractor, Supplier, other individual or entity or any surety or employee or agent of any of them.

13.06 Correction or Removal of Defective Work

A. If required by CITY, CONTRACTOR shall promptly, as directed, either correct all defective Work, whether or not fabricated, installed or completed, or, if the Work has been rejected by either DESIGN PROFESSIONAL or CITY's Representative, remove it and replace it

with Work that is not defective. CONTRACTOR shall pay all costs, losses and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) caused by or resulting from such correction or removal (including but not limited to all costs of repair or replacement of work of others).

13.07 Correction Period

A. If within one (1) year after the date of Substantial Completion, or such longer period of time as may be prescribed by Laws or Regulations, by the terms of any applicable special guarantee required by the Contract Documents, or by any specific provision of the Contract Documents, any Work is found to be defective, or if the repair of any damages to the land or areas made available for CONTRACTOR's use by CITY or permitted by Laws and Regulations as contemplated in Paragraph 6.10 is found to be defective, CONTRACTOR shall promptly, without cost to CITY and in accordance with CITY's written instructions:

1. correct the repair of damages to such land or areas; or
2. correct such defective Work, or if it has been rejected by CITY, remove it from the Site and replace it with Work that is not defective; and
3. satisfactorily correct or remove and replace any damage to other Work or to the work of others or damage to other lands or areas resulting therefrom. If CONTRACTOR does not promptly comply with the terms of such instructions, or in the event of an emergency where delay by CONTRACTOR would cause serious risk of loss or damage, CITY may have the defective Work corrected or the rejected Work removed and replaced, and all costs, losses and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) caused by or resulting from such removal and replacement (including but not limited to all costs of repair or replacement of work of others) will be paid by CONTRACTOR.

B. In special circumstances where a particular item of equipment is placed in continuous service before Substantial Completion of all the Work, the correction period for that item may start to run from an earlier date if so provided in the Specifications or by Written Amendment.

C. Where defective Work (and damage to other Work resulting therefrom) has been corrected or removed and replaced under this Paragraph 13.07, the correction period hereunder with respect to such Work will be extended for an additional period of one (1) year, or such longer period of time as may be prescribed within Paragraph 13.07 A, after such correction or removal and replacement has been satisfactorily completed.

D. CONTRACTOR's obligations under this Paragraph 13.07 are in addition to any other obligation or warranty. The provisions of this Paragraph 13.07 shall not be construed as a substitute for or waiver of the provisions of any applicable statute of limitation or repose.

13.08 Acceptance of Defective Work

A. If, instead of requiring correction or removal and replacement of defective Work, CITY prefers to accept it, CITY may do so. CONTRACTOR shall pay all costs, losses and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) attributable to CITY's evaluation of and determination to accept such defective Work and shall pay OWNER for the diminished value of the Work. If any such acceptance occurs prior to DESIGN PROFESSIONAL's recommendation of final payment, a Change Order will be issued incorporating the necessary revisions into the Contract Documents with respect to the Work and, due to the diminished value of the Work, CITY shall be entitled to an appropriate decrease in the Contract Price. If the parties are unable to agree as to the amount thereof, CITY may make a Claim therefore as provided in Article 16. If the acceptance of defective Work occurs after such recommendation, an appropriate amount shall be paid by CONTRACTOR to CITY.

13.09 CITY May Correct Defective Work

A. If CONTRACTOR fails within a reasonable time after written notice from DESIGN PROFESSIONAL or CITY's Representative to correct defective Work or to remove and replace rejected Work as required by CITY in accordance with Paragraph 13.06, or if CONTRACTOR fails to perform the Work in accordance with the Contract Documents, or if CONTRACTOR fails to comply with any other provision of the Contract Documents, CITY may, after seven (7) days written notice to CONTRACTOR, correct and remedy any such deficiency.

B. CITY shall proceed expeditiously when exercising the rights and remedies under this Paragraph 13.09. In connection with such corrective and remedial action, CITY may exclude CONTRACTOR from all or part of the Site; take possession of all or part of the Work and suspend CONTRACTOR's services related thereto; take possession of CONTRACTOR's tools, appliances, construction equipment and machinery at the Site; and incorporate into the Work all materials and equipment stored at the Site or for which CITY has paid CONTRACTOR but which are stored elsewhere. CONTRACTOR shall allow CITY, CITY's Representative, agents and employees, CITY's other contractors, DESIGN PROFESSIONAL and Consultants access to the Site to enable CITY to exercise the rights and remedies under this Paragraph 13.09.

C. All costs, losses and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) incurred or sustained by CITY in exercising such rights and remedies will be charged against CONTRACTOR and a Change Order will be issued incorporating the necessary revisions into the Contract Documents with respect to the Work; and CITY shall be entitled to an appropriate decrease in the Contract Price. If CITY and CONTRACTOR are unable to agree as to the amount thereof, CITY may make a Claim therefore as provided in Article 16. Such Claims for costs, losses and damages will include but not be limited to all costs of repair or replacement of work of others destroyed or damaged by correction, removal and replacement of CONTRACTOR's defective or rejected Work.

D. CONTRACTOR shall not be allowed an extension of the Contract Times (or Milestones) because of any delay in the performance of the Work attributable to the exercise by CITY of CITY's rights and remedies under Paragraphs 13.06 and 13.09.

ARTICLE 14 PAYMENTS TO CONTRACTOR AND COMPLETION

14.01 Schedule of Values

A. 01290.02 Schedule of Values established as provided in Article 2 will serve as the basis for progress payments and will be incorporated into form 01290.01 Application for Payment acceptable to DESIGN PROFESSIONAL and CITY. Progress payments for Unit Price Work will be based on the number of units completed.

14.02 Application for Progress Payments

A. Application for Payment

1. At least twenty (20) days before the date stipulated in the Supplementary Conditions for each progress payment (but not more often than once a month), CONTRACTOR shall submit to DESIGN PROFESSIONAL for review an Application for Payment filled out and signed by CONTRACTOR covering the Work completed as of the date of the Application and accompanied by such supporting documentation as is required by the Contract Documents. If payment is requested on the basis of materials and equipment not incorporated into the Work but delivered and suitably stored at the Site or at another location agreed to in writing, the Application for Payment shall also be accompanied by a bill of sale, paid invoice or other documentation warranting that CITY has received the materials and equipment free and clear of all Liens and evidence that the materials and equipment are covered by appropriate property insurance and other arrangements to protect CITY's interest therein, all of which will be subject to CITY's approval.

2. Beginning with the second Application for Payment, each Application shall include:

a. an affidavit of CONTRACTOR stating that all previous progress payments received for the Work have been applied to discharge CONTRACTOR's legitimate obligations associated with prior Applications for Payment, and

b. a copy of the most recent 00485.01 M/WBE Monthly Utilization Report CONTRACTOR has submitted to the CITY's Human Relations Department.

c. a copy of the most recent 00485.02 Project Workforce Monthly Report and 00485.03 Company-Wide Workforce Monthly Report CONTRACTOR has submitted to the OWNER's Human Relations Department.

d. an update to the approved schedule pursuant to paragraphs 6.04 and 6.05.

3. The amount of retainage with respect to progress payments will be stated in the Supplementary Conditions.

B. Review of Applications

1. DESIGN PROFESSIONAL will, within ten (10) days after receipt of each Application for Payment, either indicate in writing a recommendation of payment and present the Application to CITY, or return the Application to CONTRACTOR indicating in writing DESIGN PROFESSIONAL's reasons for refusing to recommend payment. In the latter case, CONTRACTOR shall make the necessary corrections and resubmit the Application.

a. After presentation of the Application for Payment to CITY, and if CITY's Representative agrees with DESIGN PROFESSIONAL's recommendation, the amount recommended will (subject to the provisions of Paragraph 14.02 B.4) become due and will be paid by CITY to CONTRACTOR, subject to the provisions of Laws or Regulations.

b. No payment shall be approved until the CONTRACTOR has submitted with the Application accompanying documentation as required by the Contract Documents, including, but not limited to, the documentation required by paragraphs 6.04 and 6.05.

2. DESIGN PROFESSIONAL's recommendation of any payment requested in an Application for Payment will constitute a representation by DESIGN PROFESSIONAL to CITY, based on DESIGN PROFESSIONAL's observations of the executed Work as an experienced and qualified DESIGN PROFESSIONAL and on DESIGN PROFESSIONAL's review of the Application for Payment and the accompanying data and schedules, that to the best of DESIGN PROFESSIONAL's knowledge, information and belief:

a. the Work has progressed to the point indicated;

b. the quality of the Work is generally in accordance with the Contract Documents (subject to an evaluation of the Work as a functioning whole prior to or upon Substantial Completion, to the results of any subsequent tests called for in the Contract Documents, to a final determination of quantities and classifications for Unit Price Work under Paragraph 9.06, and to any other qualifications stated in the recommendation); and

c. the conditions precedent to CONTRACTOR being entitled to such payment appear to have been fulfilled in so far as it is DESIGN PROFESSIONAL's responsibility to observe the Work.

3. DESIGN PROFESSIONAL's recommendation of any payment, including final payment, shall not mean that DESIGN PROFESSIONAL is responsible for CONTRACTOR's means, methods, techniques, sequence or procedures of construction, safety precautions and programs incident thereto, or any failure of CONTRACTOR to comply with Laws or Regulations applicable to the furnishing or performance of Work.

4. DESIGN PROFESSIONAL may refuse to recommend the whole or any part of any payment if, in DESIGN PROFESSIONAL's opinion, it would be incorrect to make the representations to CITY referred to in Paragraph 14.02 B.2. DESIGN PROFESSIONAL may also refuse to recommend any such payment or, because of subsequently discovered

evidence or the results of subsequent inspections or tests, nullify any such payment previously recommended, to such extent as may be necessary in DESIGN PROFESSIONAL's opinion to protect CITY from loss because:

- a. the Work is defective, or completed Work has been damaged requiring correction or replacement;
- b. the Contract Price has been reduced by Written Amendment or Change Orders;
- c. CITY has been required to correct defective Work or complete Work in accordance with Paragraph 13.09; or
- d. DESIGN PROFESSIONAL has actual knowledge of the occurrence of any of the events enumerated in Paragraph 15.02.

C. Reduction in Payment

1. CITY may refuse to make payment of the full amount recommended by DESIGN PROFESSIONAL because:

- a. Claims have been made by third parties against CITY on account of CONTRACTOR's performance or furnishing of the Work; or
- b. Claims have been made by CITY against CONTRACTOR in connection with the Work, except where CONTRACTOR has delivered a specific Bond satisfactory to CITY to secure the satisfaction and discharge of such Claims;
- c. there are other items entitling CITY to a set-off against the amount recommended; or
- d. CITY has actual knowledge of the occurrence of any of the events enumerated in Paragraphs 14.02 B.4.a through c or 15.02 A.1 through 4; but CITY must give CONTRACTOR written notice (with a copy to DESIGN PROFESSIONAL) stating the reasons for such action and promptly pay CONTRACTOR the amount so withheld, or any adjustment thereto agreed to by CITY and CONTRACTOR, when CONTRACTOR corrects to CITY's satisfaction the reasons for such action; or
- e. CITY has made a different determination of the actual quantities and classifications of Unit Price Work.

14.03 CONTRACTOR's Warranty of Title

A. CONTRACTOR warrants and guarantees that title to all Work, materials and equipment covered by any Application for Payment, whether incorporated into the Project or not, will pass to CITY no later than the time of payment, free and clear of all Liens.

14.04 Substantial Completion

A. When CONTRACTOR considers the entire Work ready for its intended use CONTRACTOR shall notify CITY and DESIGN PROFESSIONAL in writing that the entire Work is substantially complete (except for items specifically listed by CONTRACTOR as incomplete) and request that CITY issue a certificate of Substantial Completion. Within a reasonable time thereafter, CITY, together with CONTRACTOR and DESIGN PROFESSIONAL, shall make an inspection of the Work to determine the status of completion. If DESIGN PROFESSIONAL does not consider the Work substantially complete, DESIGN PROFESSIONAL will notify CONTRACTOR and CITY in writing giving the reasons therefore. If DESIGN PROFESSIONAL considers the Work substantially complete, DESIGN PROFESSIONAL will prepare and deliver to CITY a recommended certificate of Substantial Completion that shall establish the date of Substantial Completion. There shall be attached to the certificate a tentative list of items to be completed or corrected before final payment. CITY shall have seven (7) days after receipt of the recommended certificate during which to make written objection to DESIGN PROFESSIONAL as to any provisions of the certificate or attached list. At the time of delivery of the recommended certificate of Substantial Completion, DESIGN PROFESSIONAL will deliver to

CITY and CONTRACTOR a written recommendation as to division of responsibilities pending final payment between CITY and CONTRACTOR with respect to security, operation, safety, protection of the Work, maintenance, heat, utilities, insurance and warranties and guarantees.

B. CITY shall have the right to exclude CONTRACTOR from the Site after the date of Substantial Completion, but CITY shall allow CONTRACTOR reasonable access to complete or correct items on the tentative list.

14.05 Partial Utilization

A. Use by CITY at CITY's option of any substantially completed part of the Work which has specifically been identified in the Contract Documents, or which CITY, DESIGN PROFESSIONAL and CONTRACTOR agree constitutes a separately functioning and usable part of the Work that can be used by CITY for its intended purpose without significant interference with CONTRACTOR's performance of the remainder of the Work, may be accomplished prior to Substantial Completion of all the Work subject to the following:

1. CITY at any time may request CONTRACTOR in writing to permit CITY to use any such part of the Work which CITY believes to be ready for its intended use and substantially complete. If CONTRACTOR agrees that such part of the Work is substantially complete, CONTRACTOR will certify to CITY and DESIGN PROFESSIONAL that such part of the Work is substantially complete and request CITY to issue a certificate of Substantial Completion for that part of the Work. CONTRACTOR at any time may notify CITY and DESIGN PROFESSIONAL in writing that CONTRACTOR considers any such part of the Work ready for its intended use and substantially complete and request CITY to issue a certificate of Substantial Completion for that part of the Work. Within a reasonable time after either such request, CITY, together with CONTRACTOR and DESIGN PROFESSIONAL, shall make an inspection of that part of the Work to determine its status of completion. If DESIGN PROFESSIONAL does not consider that part of the Work to be substantially complete, DESIGN PROFESSIONAL will notify CITY and CONTRACTOR in writing, giving the reasons therefore. If DESIGN PROFESSIONAL considers that part of the Work to be substantially complete, the provisions of Paragraph 14.04 will apply with respect to certification of Substantial Completion of that part of the Work and the division of responsibility in respect thereof and access thereto.

2. No occupancy or separate operation of part of the Work will be accomplished prior to compliance with the requirements of Paragraph 5.09 with respect to property insurance.

14.06 Final Inspection

A. Upon written notice from CONTRACTOR that the entire Work or an agreed portion thereof is complete, DESIGN PROFESSIONAL will make a final inspection with CITY and CONTRACTOR and will notify CONTRACTOR in writing of all particulars in which this inspection reveals that the Work is incomplete or defective. CONTRACTOR shall immediately take such measures as are necessary to complete such Work or remedy such deficiencies.

14.07 Final Payment

A. Application for Payment

1. After CONTRACTOR has completed all corrections required by Paragraph 14.06 to the satisfaction of DESIGN PROFESSIONAL and CITY's Representative and delivered in accordance with the Contract Documents all maintenance and operating instructions, schedules, guarantees, Bonds, certificates or other evidence of insurance required by Paragraph 5.04, certificates of inspection, marked-up record documents (as provided in Paragraph 6.13) and other documents, CONTRACTOR may make application for final payment following the procedure for progress payments.

2. The final Application for Payment shall be accompanied (except as previously delivered) by:

- a. all documentation required by the Contract Documents, including but not limited to the evidence of insurance required by Subparagraph 5.04 B.7; and
- b. 01290.14 "Contractor Affidavit for Final Payment" from CONTRACTOR and 01290.15 "Subcontractor Affidavit for Final Payment" from all Subcontractors, regardless of tier.

B. Review of Application and Acceptance

1. If, on the basis of DESIGN PROFESSIONAL's and CITY's Representative's observation of the Work during construction and final inspection, and DESIGN PROFESSIONAL's and CITY's Representative's review of the final Application for Payment and accompanying documentation as required by the Contract Documents, DESIGN PROFESSIONAL and CITY's Representative are satisfied that the Work has been completed and CONTRACTOR's other obligations under the Contract Documents have been fulfilled, DESIGN PROFESSIONAL will, within ten (10) days after receipt of the final Application for Payment, indicate in writing DESIGN PROFESSIONAL's and CITY's Representative's recommendation of payment and present the Application to CITY for payment. At the same time DESIGN PROFESSIONAL will also give written notice to CITY and CONTRACTOR that the Work is acceptable subject to the provisions of Paragraph 14.09.

2. Otherwise, DESIGN PROFESSIONAL will return the Application to CONTRACTOR, indicating in writing the reasons for refusing to recommend final payment, in which case CONTRACTOR shall make the necessary corrections and resubmit the Application to DESIGN PROFESSIONAL. After the presentation to CITY of the Application and accompanying documentation, in appropriate form and substance, including applicable federal and state prevailing wage provisions, and with DESIGN PROFESSIONAL's recommendation and notice of acceptability, the amount recommended by DESIGN PROFESSIONAL will become due and will be paid by CITY to CONTRACTOR in accordance with Laws and Regulations.

14.08 Final Completion Delayed

A. If, through no fault of CONTRACTOR, final completion of the Work is significantly delayed and if DESIGN PROFESSIONAL so recommends and CITY concurs, CITY shall, upon receipt of CONTRACTOR's final Application for Payment and recommendation of DESIGN PROFESSIONAL, and without terminating the Contract, make payment of the balance due for that portion of the Work fully completed and accepted. If the remaining balance to be held by CITY for Work not fully completed or corrected is less than the retainage stipulated in the Supplementary Conditions, and if Bonds have been furnished as required in Paragraph 5.01, the written consent of the surety to the payment of the balance due for that portion of the Work fully completed and accepted shall be submitted by CONTRACTOR to DESIGN PROFESSIONAL with the Application for Payment. Payment shall be made under the terms and conditions governing final payment, except that it shall not constitute a waiver of Claims.

14.09 Waiver of Claims

A. The making and acceptance of final payment will constitute:

1. a waiver of all claims by CITY against CONTRACTOR, except claims previously made in writing and still unsettled, or claims arising from defective Work appearing after final inspection pursuant to Paragraph 14.06, from failure to comply with the Contract Documents or the terms of any special guarantees specified therein, or from CONTRACTOR's continuing obligations under the Contract Documents; and

2. a waiver of all Claims by CONTRACTOR against CITY other than those previously made in writing pursuant to Paragraphs 16.02 and 16.03 and still unsettled.

14.10 Completion of Work by CITY

A. If CITY must complete the Work, all costs and charges incurred by CITY, together with the cost of completing the Work under the Contract, will be deducted from any monies due or which may become due CONTRACTOR. If such expense exceeds the sum which would have been payable under the Contract, then CONTRACTOR and the surety shall be liable and shall pay to CITY the amount of such excess.

ARTICLE 15 SUSPENSION OF WORK AND TERMINATION

15.01 CITY May Suspend Work

A. Notwithstanding any other provision of this Contract, at any time and without cause, and at its sole and absolute discretion, CITY, may suspend the Work or any portion of the Work by written notice to CONTRACTOR, which will initially fix the date on which Work will be resumed. CONTRACTOR shall resume the Work on the date so fixed in the notice unless the date is changed by a subsequent written notice from CITY. CONTRACTOR may be allowed an adjustment in the Contract Price or an extension of the Contract Times, or both, directly attributable to any suspension if CONTRACTOR makes a Claim therefore in accordance with Article 16.

B. CONTRACTOR will not be allowed an adjustment in the Contract Price or an extension of the Contract Times if CITY suspends the Work because CONTRACTOR's acts or omissions create or cause an emergency that CITY believes affects the safety or protection of persons, the Work, or property at the Site or adjacent thereto. CITY may order CONTRACTOR to stop the Work, or any portion thereof, until the cause for such order has been adequately addressed by CONTRACTOR; however, this right of CITY to stop the Work shall not give rise to any duty on the part of CITY to exercise this right for the benefit of CONTRACTOR, any Subcontractor, Supplier, other individual or entity or any surety or employee or agent of any of them.

15.02 CITY May Terminate for Default

A. CONTRACTOR may be deemed in default and CITY may terminate the services of CONTRACTOR upon the occurrence of any one or more of the following events:

1. CONTRACTOR fails to perform the Work in accordance with the Contract Documents (including, but not limited to, failure to supply sufficient skilled workers or suitable materials or equipment or failure to adhere to the progress schedule established under Paragraph 2.06 and 2.07 as adjusted from time to time pursuant to Paragraphs 6.04, 6.05, 12.02 and 12.03);
2. CONTRACTOR abandons the Work or declares its intention to abandon the Work;
3. CONTRACTOR assigns or attempts to assign its rights or obligations under this Contract or any part thereof to any third party without the prior written consent of CITY;
4. CONTRACTOR fails to make prompt payment duly owing to any subcontractor for Work completed in accordance to the Contract Documents or material supplier for materials delivered for incorporation into the Work within thirty (30) calendar days after payment was due;
5. CONTRACTOR fails to achieve the required dates of substantial and final completion;
6. CONTRACTOR disregards Laws or Regulations of any public body having jurisdiction;
7. CONTRACTOR disregards the authority of DESIGN PROFESSIONAL or OWNER;
or
8. CONTRACTOR otherwise violates in any substantial way any provisions of the Contract Documents.

B. CITY may, after giving CONTRACTOR (and the surety) seven (7) days written notice and to the extent permitted by Laws or Regulations, terminate the services of CONTRACTOR, exclude CONTRACTOR from the Site and take possession of the Work and of all CONTRACTOR's tools, appliances, construction equipment and machinery at the Site and use the same to the full extent they could be used by CONTRACTOR (without liability to

CONTRACTOR for trespass or conversion), incorporate into the Work all materials and equipment stored at the Site or for which CITY has paid CONTRACTOR but which are stored elsewhere, and finish the Work as CITY may deem expedient. In such case, CONTRACTOR shall not be entitled to receive any further payment until the Work is finished. If the unpaid balance of the Contract Price exceeds all costs, losses and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) sustained by CITY arising out of or resulting from completing the Work, such excess may be paid to CONTRACTOR. If such costs, losses and damages exceed such unpaid balance, CONTRACTOR shall pay the difference to CITY within fourteen (14) calendar days of CITY'S demand for payment. When exercising any rights or remedies under this Paragraph CITY shall not be required to competitively bid this work unless required by law.

C. Where CONTRACTOR'S services have been so terminated by CITY, the termination will not affect any rights or remedies of CITY against CONTRACTOR then existing or which may thereafter accrue. Any retention or payment of moneys due CONTRACTOR by CITY will not release CONTRACTOR from liability.

D. If, after a default termination, it is determined that the CONTRACTOR was not in default, the rights and obligations of the parties shall be the same as if the termination had been issued for the convenience of the CITY. The CITY shall then be liable to CONTRACTOR for only those costs enumerated in paragraph 15.03.

15.03 CITY May Terminate for Convenience

A. Notwithstanding any other provision of this Contract, upon seven (7) calendar days written notice to CONTRACTOR, CITY may, at its sole and absolute discretion, without cause and without prejudice to any other right or remedy of CITY, elect to terminate the Contract. In such case, CONTRACTOR shall, with thirty (30) calendar days of receiving notice of termination under this paragraph, submit to CITY its statement of costs and expenses and shall be paid:

1. for completed and acceptable Work executed in accordance with the Contract Documents prior to the effective date of termination, including fair and reasonable sums for overhead and profit on such Work;

2. for expenses sustained prior to the effective date of termination in performing services and furnishing labor, materials or equipment as required by the Contract Documents in connection with uncompleted Work, plus fair and reasonable sums for overhead and profit on such expenses;

3. for all costs, losses and damages incurred in settlement of terminated contracts with Subcontractors, Suppliers and others; and

4. for reasonable expenses directly attributable to termination if approved in advance by CITY.

B. CONTRACTOR shall not be paid on account of loss of anticipated profits or revenue or other economic loss arising out of or resulting from such termination.

C. CONTRACTOR waives any costs not submitted to CITY pursuant to paragraph 15.03.A.

D. CITY shall, within thirty (30) calendar days after receipt of CONTRACTOR'S statement, pay CONTRACTOR all amounts it determines are properly determined.

ARTICLE 16 CLAIMS AND DISPUTES

16.01 Definition

A. A Claim is a demand or assertion by the CONTRACTOR seeking, as a matter of right, the adjustment of Contract price and/or times with respect to the terms of the Contract.

16.02 Written Notice and Burden of Proof

A. Claims must be made by written notice pursuant to Paragraph 17.01. The written notice shall clearly indicate that the CONTRACTOR is making a claim. The responsibility to substantiate Claims shall rest with the CONTRACTOR. No Claim may be made under this Contract except as provided in this Article.

B. Certification of Claim: The written notice of Claim shall include the following statement signed by the CONTRACTOR's representative: "The CONTRACTOR certifies that all statements made and the facts set out in this claim are true and correct and that no false records have been submitted in support of this claim." **Strict compliance with this paragraph shall be a condition precedent to the creation, existence or validity of any Claim.**

16.03 Time Limits on Claims

A. The CONTRACTOR must give notice to the CITY within fourteen (14) calendar days after the denial of a request for or failure to reach an agreement on a change in Contract Price and/or change in Contract Time pursuant to Article 11 and Article 12 respectively. After the fourteen (14) day period for making Claims has expired, the Claim shall be considered waived.

B. The CONTRACTOR shall submit the Claim to the CITY's Representative.

16.04 Continuing Contract Performance

A. Pending final resolution of a Claim, unless otherwise agreed in writing, the CONTRACTOR shall proceed diligently with performance of the Work and the CITY shall continue to make payments in accordance with the Contract Documents. The CITY may, but is not obligated to, notify the Surety of the nature and amount of the Claim.

16.05 Injury or Damage to Person or Property

A. If either party to the Contract suffers injury or damage to person or property because of an act or omission of the other party, of any of the other party's employees or agents, or of others for whose acts that party is legally liable, written notice of the injury or damage, whether or not insured, shall be given to the other party within a reasonable time not exceeding thirty (30) days after first observance. The notice shall provide sufficient detail to enable the other party to investigate the matter.

16.06 Initial Resolution of Claims and Disputes

A. After the CONTRACTOR has submitted the Claim to the CITY's Representative, the CITY'S Representative and CONTRACTOR'S Representative shall conduct a settlement conference within fourteen (14) calendar days from the date of receipt of the Claim. If the Claim is not settled within seven (7) calendar days following the date of the settlement conference, the CITY'S Representative and the CONTRACTOR's Representative shall state, in writing, following the conclusion of the seven (7) calendar day period, their respective position as to the matters in dispute.

B. The CITY'S and CONTRACTOR'S statement of positions shall state all known factual grounds for each party's position. If the dispute remains unresolved at the end of the seven (7) calendar days from submission of the parties' written position statements, the CONTRACTOR shall have the right to proceed with the pursuit of Claims pursuant to paragraph 16.07.

C. If a Claim has been resolved, the OWNER will prepare or obtain appropriate documentation.

16.07 Final Resolution of Claims and Disputes

A. All administrative procedures set forth in this contract must first be exhausted before suit is filed.

B. If the CITY'S Representative and the CONTRACTOR'S Representative are unable to resolve the dispute pursuant to 16.06, the parties must submit their statements of position to the Director, who shall review the Claim and make a decision within fourteen (14) calendar days.

C. Absent fraud, gross mistake or bad faith, the Director's decision shall be final and binding on CITY and CONTRACTOR within fourteen (14) calendar days after issuance. The CONTRACTOR shall give written notice to the CITY stating its intent to submit its Claim to a court of law pursuant to paragraph 17.05.A. within thirty (30) calendar days after notice of Director's decision.

D. The time frames for the Director's decision and for CONTRACTOR'S written notice of intent may be tolled by participation in voluntary mediation. Mediator selection and the procedures to be employed in voluntary mediation shall be mutually acceptable to the parties. Costs of the mediator shall be shared equally among the parties participating in the mediation. In no event shall any time frame be tolled more than 30 days for mediation. However, mediation may be employed at any time at the discretion and mutual agreement of the parties.

E. If the dispute is not resolved during voluntary mediation, The CONTRACTOR agrees that it will file no suit based on facts or evidentiary materials that were not presented for consideration to the CITY during the mediation process or of which the CONTRACTOR had knowledge and failed to present during the administrative procedures.

ARTICLE 17 MISCELLANEOUS

17.01 Giving Notice

A. Whenever any provision of the Contract Documents requires the giving of written notice, it will be given by personal delivery, by registered or certified mail, postage prepaid, to the last business address known to the giver of the notice or by confirmed electronic facsimile transmission. Notice is effective on the date of personal delivery, deposit of registered or certified mail, postage prepaid, or confirmed electronic facsimile transmission.

17.02 Computation of Times

A. When any period of time is referred to in the Contract Documents by days, it will be computed to exclude the first and include the last calendar day of such period. If the last day of such period falls on a Saturday or Sunday or on a day made a legal holiday by the law of the applicable jurisdiction, such day will be omitted from the computation.

17.03 Cumulative Remedies

A. The duties and obligations imposed by these General Conditions and the rights and remedies available hereunder to the parties hereto, and, in particular but without limitation, the warranties, guarantees and obligations imposed upon CONTRACTOR and all of the rights and remedies available to CITY and DESIGN PROFESSIONAL hereunder are in addition to, and are not to be construed in any way as a limitation of, any rights and remedies available to any or all of them which are otherwise imposed or available by Laws or Regulations, by special warranty or guarantee or by other provisions of the Contract Documents, and the provisions of this Paragraph will be as effective as if repeated specifically in the Contract Documents in connection with each particular duty, obligation, right and remedy to which they apply.

17.04 Survival of Obligations

A. All representations, indemnifications, warranties, and guarantees made in, required by, or given in accordance with the Contract Documents, as well as all continuing obligations indicated in the Contract Documents will survive final payment, completion, and acceptance of the Work or termination or completion of the Contract.

17.05 Controlling Law

A. This Contract shall be construed and governed in accordance with the laws of the State of Missouri without giving effect to Missouri's choice of law provisions. The CITY and CONTRACTOR: (1) shall submit exclusively to the jurisdiction of the state and federal courts located in Jackson County, Missouri and no other; (2) shall waive any and all objections to jurisdiction and venue; and (3) shall not raise forum non conveniens as an objection to the location of any litigation.



SUPPLEMENTARY CONDITIONS

Project Number 89022000

Project Title CM @ RISK Kansas City Downtown Streetcar

These Supplementary Conditions amend or supplement the General Conditions of the Construction Contract and other provisions of the Contract Documents as indicated below. All provisions that are not so amended or supplemented remain in full force and effect.

SC-1.01 Article 1, Paragraph 1.01, Defined Terms; Definition 16. Contract Documents is supplemented as follows:

16. Contract Documents- The Contract Documents establish the rights and obligations of the parties and include the Contract, Addenda (which pertain to the Contract Documents), CONTRACTOR's Bid Form/Contract (including documentation accompanying the Bid and any post Bid documentation submitted prior to the Notice of Intent to Contract), the Notice to Proceed, the Bonds, these General Conditions, the Supplementary Conditions, the Federal Transit Administration Required Contract Clauses and Certifications, the Specifications and the Drawings as the same are more specifically identified in the Project Manual and the certification page(s) of the DESIGN PROFESSIONAL and Consultant(s), together with approved Project baseline schedule and amendments thereto and all Written Amendments, Change Orders, Work Change Directives, and DESIGN PROFESSIONAL's written interpretations and clarifications issued on or after the Effective Date of the Contract, and approved Shop Drawings. Reports and drawings of subsurface and physical conditions are not Contract Documents. Only printed or hard copies of the items listed in this Paragraph are Contract Documents. Files in electronic media format of text, data, graphics, and the like that may be furnished by CITY to CONTRACTOR are not Contract Documents, except Project schedules submitted by CONTRACTOR and approved by CITY.

SC-1.01 Article 1, Paragraph 1.01, Defined Terms, Subparagraph 1.01 is amended by deleting Paragraph 19 and replacing with the following:

19. **CONTRACTOR/CM @Risk** - The person, firm, partnership, company, corporation or association licensed or otherwise authorized by law to do business in Missouri, with whom CITY has entered into the Agreement.

SC-1.01 Article 1, Paragraph 1.01, Defined Terms, Subparagraph 1.01 amended by adding the following Paragraphs:

55. **Construction Manager/General Contractor at Risk (CM@Risk)** – The CONTRACTOR.

56. **Construction Manager Fee (CM Fee)** – The amount CONTRACTOR is charging the CITY for overhead costs and profit associated with the Work.

57. **Construction Manager General Conditions Price (CM GC Price)** – The amount CONTRACTOR is charging City for Indirect Costs excluding the overhead and profit. This amount shall not contain Project contingency.

58. **Direct Costs** – Cost of all direct labor, equipment and materials required to complete CONTRACTOR’S Work.

59. **IGMP** – Initial Guaranteed Maximum Price of the Project that is established prior to DESIGN PROFESSIONAL’s development of the final design and scope of documents for the Project. This amount is the sum of the CM Fee CM/GC, and initial estimate of the Direct Costs.

60. **FGMP** – Final Guaranteed Maximum Price of the Project that is established after Preconstruction Phase 1 and upon completion of DESIGN PROFESSIONAL’s detailed design development for the Project. This amount is the sum of the CM Fee, CM GC, and CONTRACTOR’s estimate of the Direct Costs (including any contingency agreed upon by CM/GC@Risk and CITY.

61. **Cost of the Work** – The actual total Cost of the Work, including actual Direct Costs, but excluding the CM Fee, and any contingency, as more fully defined in Section 11.02.

62. **Project Management Oversight Consultant (PMOC)** – FTA Appointed Consultant to provide Project management oversight.

SC-4.02 Article 4, Paragraph 4.02, Subsurface and Physical Conditions; Subparagraphs A and B are supplemented as follows:

In the preparation of the Contract Documents, no reports of explorations and tests of subsurface conditions at or contiguous to the Site of the Work *are available*

In the preparation of the Contract Documents, no drawings of physical conditions in or relating to existing surface or subsurface structures which are at or contiguous to the Site of the Work are available.

SC-4.06 Article 4, Paragraph 4.06, Asbestos, Lead-Based Paint, PCBs, Petroleum Waste or Radioactive Material, Subparagraphs A and B are supplemented as follows:

In the preparation of the Contract Documents, the following reports and drawings relating to a Hazardous Environmental Condition identified at the Site of the Work were utilized:

1. Report dated September 2012, prepared by HDR Inc.; entitled Environmental Assessment Kansas City Downtown Streetcar Project , which may be reviewed at **414 East 12th Street 18th Floor, Kansas City Missouri** The technical data contained in such report upon which CONTRACTOR may rely is included in the document. .

SC- 5.01 A. Article 5, Paragraph 5.01, Performance, Payment and Other Bonds, Subparagraph A, second sentence, is revised as follows:

These Bonds shall remain in effect at least until **(2) years** after the date when final payment becomes due, except as provided otherwise by Laws or Regulations or by the Contract Documents. CONTRACTOR shall furnish the following additional Bonds, which shall remain in effect as stated

SC-5.03 A. Article 5, Paragraph 5.03 Certificates of Insurance, Subparagraph A is amended by adding the following Subparagraph 1:

1. CONTRACTOR shall obtain evidence that all Subcontractors have in force the required coverage in the amounts required by these Contract Documents, and evidence that each is current on its unemployment insurance payments before Subcontractors begin Work at the

Site. CONTRACTOR shall retain such evidence in its files and make available to CITY within ten (10) days after written request.

SC-5.04 B.1. Article 5, Paragraph 5.04, CONTRACTOR's Liability Insurance, Subparagraph B.1 is amended as follows:

With respect to insurance required by Paragraphs 5.04 A.3 through 5.04 A.5, the following additional individuals or entities shall be listed as additional insureds:

With respect to Commercial Automobile Liability Insurance and Commercial General Liability Insurance, the Federal Transit Administration (FTA), Downtown Transportation Development District (TDD), Kansas City Streetcar Authority (KCSA) and the Project Management Oversight Consultant (PMOC) - Kansas City Area Transportation Authority (KCATA) and each of their respective employees shall be listed as additional insureds.

SC-5.04 C. Article 5, Paragraph 5.04, CONTRACTOR's Liability Insurance, Subparagraph C is amended as follows:

The following additional policies of insurance are required:

5. Railroad Protective Liability Insurance. This insurance shall be issued in the name of the Railroad Company specified below and shall protect and defend the railroad against claims arising as a result of the operations of CONTRACTOR. This insurance shall be acceptable to the railroad and shall be maintained in force throughout the period when CONTRACTOR is working on or adjacent to property owned by the railroad. CONTRACTOR shall not enter upon the Railroad Company's premises until this insurance is in effect. The aggregate liability limits per job site for bodily injury and property damage shall be not less than those limits required by the respective Railroad Company.

Railroad Protective Liability Insurance shall be issued in the name of the following railroad(s):
Kansas City Terminal Railway Company only for work required to be performed outside of the bridge deck over the tracks south of 20th Street

SC-5.06 A. Article 5, Paragraph 5.06, Property Insurance, Paragraph A, is amended by adding the following after the first sentence:

Property Insurance on the Work at the Site shall be written with a deductible amount not to exceed \$10,000.00.

SC-6.01. Article 6, Paragraph 6.01, Indemnification, is supplemented by adding Subparagraph F as follows:

- F. CONTRACTOR shall defend, indemnify and hold harmless the Federal Transit Administration (FTA), Downtown Transportation Development District (TDD), Kansas City Streetcar Authority (KCSA) and the Project Management Oversight Consultant (PMOC) - Kansas City Area Transportation Authority (KCATA) and each of their respective employees from and against all Claims arising out of or resulting from all acts or omissions in connection with this Contract caused in whole or in part by CONTRACTOR or CONTRACTOR'S Agents, regardless of whether or not caused in part by any act or omission, including negligence, of OWNER. CONTRACTOR'S obligations under this subparagraph shall be limited to the coverage and limits of insurance that CONTRACTOR is required to procure and maintain under this Contract. CONTRACTOR affirms that it has had the opportunity to recover the costs of the liability insurance required in this Contract in its contract price. For purposes of this subparagraph, Claims as defined in subparagraph A.1 shall be expanded to also mean all claims, damages, liability, losses, costs and expenses, including court costs and reasonable attorney's fees, incurred by MoDOT and MHTC.

SC-6.06 A.1 Article 6, Paragraph 6.06 Substitutes and "Or-Equal" Items, Paragraph A is amended by adding the following at the end of Paragraph A.1:

Proposed "or-equal" items must be submitted to CITY at least 10 days prior to Bid date at the following address:

414 E 12th Street 18th Floor City Hall
Kansas City, Missouri 64106
Attn: Ralph Davis, Project Manager

Only Bidders may submit proposed "or-equal" items and such items must require no change in related Work. Acceptance by CITY of any proposed "or-equal" items will be made by Addendum only.

SC-6.06 A.2. Article 6, Paragraph 6.06 Substitutes and "Or-Equal" Items, Paragraph A is amended by adding the following at the end of Paragraph A.2:

Proposed substitute items must be submitted to CITY's Representative not later than 10_ days prior to the time the item is to be incorporated into the Work. Only CONTRACTOR may submit proposed substitute items, and such items must be submitted to CITY's Representative on the standard City form 01630 - Substitution Request. Acceptance by CITY of any proposed substitute item will be made by Change Order.

SC-6.09. Article 6, Paragraph 6.09, Permits, Subparagraph A is supplemented as follows:

CONTRACTOR shall secure a permit from the Missouri Highway and Transportation Commission's District Engineer prior to performing any work in state-controlled Right-of-Way.

CONTRACTOR does not need to obtain and pay for the following construction permits and licenses, which have been paid for by CITY:

SC-6.10. Article 6, Paragraph 6.10, Compliance with Laws and Regulations, is amended by adding the following new Subparagraphs immediately following Subparagraph 6.10 I 2:

a. CONTRACTOR will be required to comply with wage rates as follows:

County –	Jackson,
Work Type:	Federal – Heavy
	State – Heavy

SC-6.11. Article 6, Paragraph 6.11, Taxes, is amended by adding the following sentence to Subparagraph 6.11 B:

A. Tax Compliance. The following subparagraphs apply if the Contract is over \$127,000.00.

SC-12.01 Article 12, Paragraph 12.01, Time of the Essence is amended by adding the following new Subparagraphs immediately following Subparagraph 12.01 A:

B. Starting and Completion

1. The Work to be performed under this Contract shall begin on the date specified in the written Notice to Proceed issued by the Director of Public Works, and the Work shall be substantially complete, in accordance with Paragraph 14.04, on or before May 31, 2015 or date agreed upon at FGMP. Once the Work starts, CONTRACTOR shall continuously pursue completion of the Work.

2. The Work shall be completed and ready for final payment in accordance with Paragraph 14.07 within 60 Calendar Days after the date of Substantial Completion of the Work.

B. Liquidated Damages

1. If the Work is not substantially completed, in accordance with Paragraph 14.04, on or before Date Agreed upon at FGMP within the period stated in Paragraph 12.01 B.1, CONTRACTOR shall pay to CITY the amount of *Amount to be negotiated at FGMP* as liquidated damages and not as a penalty for each Calendar Day until the Work is substantially complete. The amount of liquidated damages shall be deducted from any payments due or to become due CONTRACTOR.
2. If the Work is not completed and ready for final payment in accordance with Paragraph 14.07, within the period stated in Paragraph 12.01 B.2, CONTRACTOR shall pay to CITY the amount of *Amount to be negotiated at FGMP* as liquidated damages and not as a penalty for each Calendar Day until the Work is completed and ready for final payment. The amount of liquidated damages shall be deducted from any payments due or to become due CONTRACTOR.

SC-14.02 A. Article 14, Paragraph 14.02, Application for Progress Payments, Subparagraph A is amended by deleting Item 3 and adding the following:

3. CITY shall make payments to CONTRACTOR monthly on or about the 30th day of each month. Payments to CONTRACTOR will be made on the basis of the value of the Work satisfactorily completed plus the value of properly stored and insured, unused materials on hand on the Site of the Work. All Work covered by a payment becomes CITY's property, provided that the Work paid for remains the sole responsibility of CONTRACTOR until all terms and conditions of the Contract have been met.

SC-18.01 The General Conditions are amended by adding the following Article(s):

ARTICLE 18 The Federal Transit Administration Required Contract Provisions and Kansas City Area Transportation Authority.

- A. FTA requires that award can only be made to responsible contractors possessing the ability, willingness, and integrity to perform successfully under the terms and conditions of the contract. Responsibility criteria include administrative and technical capacity, production capability, timeliness, and satisfactory current or past performance record.
- B. The following FTA Requirements apply to this Contract:
 1. **No Federal Government Obligations to Third Parties.** In connection with the Project, the Recipient agrees that, absent the Federal Government's express written consent, the Federal Government shall not be subject to any obligations or liabilities to any sub-recipient, lessee, third party contractor, or other participant at any tier of the Project, or other person or entity that is not a party to the Grant Agreement or Cooperative Agreement for the Project. Notwithstanding that the Federal Government may have concurred in or approved any solicitation, sub-agreement, lease, third party contract, or arrangement at any tier, the Federal Government has no obligations or liabilities to any entity other than the Recipient, including any sub-recipient, lessee, third party contractor, or other participant at any tier of the Project.
 2. **False or Fraudulent Statements or Claims.** The Recipient acknowledges and agrees that:

- (a) **Civil Fraud.** The Program Fraud Civil Remedies Act of 1986, as amended, 31 U.S.C. §§ 3801 *et seq.*, and U.S. DOT regulations, “Program Fraud Civil Remedies,” 49 C.F.R. Part 31, apply to the Recipient’s activities in connection with the Project. By executing the Grant Agreement or Cooperative Agreement for the Project, the Recipient certifies or affirms the truthfulness and accuracy of each statement it has made, it makes, or it may make in connection with the Project. In addition to other penalties that may apply, the Recipient also acknowledges that if it makes a false, fictitious, or fraudulent claim, statement, submission, certification, assurance, or representation to the Federal Government, the Federal Government reserves the right to impose on the Recipient the penalties of the Program Fraud Civil Remedies Act of 1986, as amended, to the extent the Federal Government deems appropriate.
 - (b) **Criminal Fraud.** If the Recipient makes a false, fictitious, or fraudulent claim, statement, submission, certification, assurance, or representation to the Federal Government or includes a false, fictitious, or fraudulent statement or representation in any agreement with the Federal Government in connection with a Project authorized under 49 U.S.C. chapter 53 or any other Federal law, the Federal Government reserves the right to impose on the Recipient the penalties of 49 U.S.C. § 5323(1), 18 U.S.C. § 1001, or other applicable Federal law to the extent the Federal Government deems appropriate.
3. **Access to Third Party Contract Records.** The Recipient agrees to require, and assures that its sub-recipients require, their third party contractors and third party subcontractors at each tier to provide to the U.S. Secretary of Transportation and the Comptroller General of the United States or their duly authorized representatives, access to all third party contract records as required by 49 U.S.C. § 5325(g). The Recipient further agrees to require, and assures that its sub-recipients require, their third party contractors and third party subcontractors, at each tier, to provide sufficient access to third party procurement records as needed for compliance with Federal laws and regulations or to assure proper Project management as determined by FTA.
4. **Changes in Project Performance (i.e., Disputes, Breaches, Defaults, or Litigation).** The Recipient agrees to notify FTA immediately, in writing, of any change in local law, conditions (including its legal, financial, or technical capacity), or any other event that may adversely affect the Recipient’s ability to perform the Project in accordance with the terms of the Grant Agreement or Cooperative Agreement for the Project and this Master Agreement. The Recipient also agrees to notify FTA immediately, in writing, of any current or prospective major dispute, breach, default, or litigation that may adversely affect the Federal Government’s interests in the Project or the Federal Government’s administration or enforcement of Federal laws or regulations; and agrees to inform FTA, also in writing, before naming the Federal Government as a party to litigation for any reason, in any forum. At a minimum, the Recipient agrees to provide each notice to FTA required by this subsection of this Master Agreement to the FTA Regional Counsel for the Region in which the Recipient operates its public transportation system or implements the Project.
5. **Civil Rights.** The Recipient agrees to comply with all applicable civil rights laws and regulations, in accordance with applicable Federal directives, except to the

extent that the Federal Government determines otherwise in writing. These include, but are not limited to, the following:

- (a) **Nondiscrimination in Federal Public Transportation Programs.** The Recipient agrees to comply, and assures the compliance of each sub-recipient, lessee, third party contractor, or other participant at any tier of the Project, with the provisions of 49 U.S.C. § 5332, which prohibit discrimination on the basis of race, color, creed, national origin, sex, or age, and prohibits discrimination in employment or business opportunity.
- (b) **Nondiscrimination – Title VI of the Civil Rights Act.** The Recipient agrees to comply, and assures the compliance of each sub-recipient, lessee, third party contractor, or other participant at any tier of the Project, with all provisions prohibiting discrimination on the basis of race, color, or national origin of Title VI of the Civil Rights Act of 1964, as amended, 42 U.S.C. §§ 2000d *et seq.*, and with U.S. DOT regulations, “Nondiscrimination in Federally-Assisted Programs of the Department of Transportation – Effectuation of Title VI of the Civil Rights Act,” 49 C.F.R. Part 21. Except to the extent FTA determines otherwise in writing, the Recipient agrees to follow all applicable provisions of the most recent edition of FTA Circular 4702.1A, “Title VI and Title VI-Dependent Guidelines for Federal Transit Administration Recipients,” and any other applicable Federal directives that may be issued.
- (c) **Equal Employment Opportunity.** The Recipient agrees to comply, and assures the compliance of each sub-recipient, lessee, third party contractor, or other participant at any tier of the Project, with all equal employment opportunity (EEO) provisions of 49 U.S.C. § 5332, with Title VII of the Civil Rights Act of 1964, as amended, 42 U.S.C. § 2000e *et seq.*, and implementing Federal regulations and any later amendments thereto. Except to the extent FTA determines otherwise in writing, the Recipient also agrees to follow all applicable Federal EEO directives that may be issued. Accordingly:
 - (1) **General.** The Recipient agrees that it will not discriminate against any employee or applicant for employment because of race, color, creed, sex, disability, age, or national origin. The Recipient agrees to take affirmative action to ensure that applicants are employed and that employees are treated during employment without regard to their race, color, religion, sex, disability, age, or national origin. Such action shall include, but not be limited to, employment, upgrading, demotions or transfers, recruitment or recruitment advertising, layoffs or terminations; rates of pay or other forms of compensation; and selection for training, including apprenticeship.
 - (2) **Equal Employment Opportunity Requirements for Construction Activities.** For activities determined by the U.S. Department of Labor (U.S. DOL) to qualify as “construction,” the Recipient agrees to comply and assures the compliance of each sub-recipient, lessee, third party contractor, or other participant, at any tier of the Project, with all requirements of U.S. DOL regulations, “Office of Federal Contract Compliance Programs, Equal Employment Opportunity, Department of Labor,” 41

C.F.R. Parts 60 *et seq.*; with implementing Executive Order No. 11246, "Equal Employment Opportunity," as amended by Executive Order No. 11375, "Amending Executive Order No. 11246 Relating to Equal Employment Opportunity," 42 U.S.C. § 2000e note, and with other applicable EEO laws and regulations, and also agrees to follow applicable Federal directives, except as the Federal Government determines otherwise in writing.

- (d) **Disadvantaged Business Enterprise.** To the extent authorized by Federal law, the Recipient agrees to facilitate participation by Disadvantaged Business Enterprises (DBEs) in the Project and assures that each sub-recipient, lessee, third party contractor, or other participant at any tier of the Project will facilitate participation by DBEs in the Project to the extent applicable as follows:
- (1) The Recipient agrees and assures that it shall comply with section 1101(b) of SAFETEA-LU, 23 U.S.C. § 101 note, and U.S. DOT regulations, "Participation by Disadvantaged Business Enterprises in Department of Transportation Financial Assistance Programs," 49 C.F.R. Part 26.
 - (2) The Recipient agrees and assures that it shall not discriminate on the basis of race, color, sex, or national origin in the award and performance of any sub-agreement, lease, third party contract, or other arrangement supported with Federal assistance derived from U.S. DOT in the administration of its DBE program and shall comply with the requirements of 49 C.F.R. Part 26. The Recipient agrees to take all necessary and reasonable steps as set forth in 49 C.F.R. Part 26 to ensure nondiscrimination in the award and administration of all sub-agreements, leases, third party contracts, and other arrangements supported with Federal assistance derived from U.S. DOT. As required by 49 C.F.R. Part 26, the Recipient's DBE program approved by U.S. DOT, if any, is incorporated by reference and made part of the Grant Agreement or Cooperative Agreement for the Project. The Recipient agrees that it has a legal obligation to implement its approved DBE program, and that its failure to carry out that DBE program shall be treated as a violation of the Grant Agreement or Cooperative Agreement for the Project and this Master Agreement. Upon notification by U.S. DOT to the Recipient of the Recipient's failure to implement its approved DBE program, U.S. DOT may impose the sanctions as set forth in 49 C.F.R. Part 26 and may, in appropriate cases, refer the matter to the appropriate Federal authorities for enforcement under 18 U.S.C. § 1001, or the Program Fraud Civil Remedies Act, 31 U.S.C. §§ 3801 *et seq.*, or both.
- (e) **Nondiscrimination on the Basis of Sex.** The Recipient agrees to comply with all applicable requirements of Title IX of the Education Amendments of 1972, as amended, 20 U.S.C. §§ 1681 *et seq.*, and with implementing U.S. DOT regulations, "Nondiscrimination on the Basis of Sex in Education Programs or Activities Receiving Federal Financial Assistance," 49 C.F.R. Part 25, that prohibit discrimination on the basis of sex.

- (f) **Nondiscrimination on the Basis of Age.** The Recipient agrees to comply with all applicable requirements of:
- (1) The Age Discrimination Act of 1975, as amended, 42 U.S.C. §§ 6101 *et seq.*, and with implementing U.S. Health and Human Services regulations, “Nondiscrimination on the Basis of Age in Programs or Activities Receiving Federal Financial Assistance,” 45 C.F.R. Part 90, which prohibit discrimination against individuals on the basis of age in the administration of programs or activities receiving Federal financial assistance.
 - (2) The Age Discrimination in Employment Act (ADEA) 29 U.S.C. §§ 621 through 634 and with implementing U.S. Equal Employment Opportunity Commission (U.S. EEOC) regulations, “Age Discrimination in Employment Act,” 29 C.F.R. Part 1625, which prohibits discrimination against individuals on the basis of age.
- (g) **Access for Individuals with Disabilities.** The Recipient agrees to comply with 49 U.S.C. § 5301(d), which states the Federal policy that elderly individuals and individuals with disabilities have the same right as other individuals to use public transportation services and facilities, and that special efforts shall be made in planning and designing those services and facilities to implement transportation accessibility rights for elderly individuals and individuals with disabilities. The Recipient also agrees to comply with all applicable provisions of section 504 of the Rehabilitation Act of 1973, as amended, 29 U.S.C. § 794, which prohibits discrimination on the basis of disability in the administration of programs or activities receiving Federal financial assistance; with the Americans with Disabilities Act of 1990 (ADA), as amended, 42 U.S.C. §§ 12101 *et seq.*, which requires that accessible facilities and services be made available to individuals with disabilities; with the Architectural Barriers Act of 1968, as amended, 42 U.S.C. §§ 4151 *et seq.*, which requires that buildings and public accommodations be accessible to individuals with disabilities; and with other laws and amendments thereto pertaining to access for individuals with disabilities that may be applicable. In addition, the Recipient agrees to comply with applicable implementing Federal regulations, and any later amendments thereto, and agrees to follow applicable Federal implementing directives, except to the extent FTA approves otherwise in writing. Among those regulations and directives are:
- (1) U.S. DOT regulations, “Transportation Services for Individuals with Disabilities (ADA),” 49 C.F.R. Part 37;
 - (2) U.S. DOT regulations, “Nondiscrimination on the Basis of Handicap in Programs and Activities Receiving or Benefiting from Federal Financial Assistance,” 49 C.F.R. Part 27;
 - (3) Joint U.S. Architectural and Transportation Barriers Compliance Board (U.S. ATBCB)/U.S. DOT regulations, “Americans With Disabilities (ADA) Accessibility Specifications for Transportation Vehicles,” 36 C.F.R. Part 1192 and 49 C.F.R. Part 38;

- (4) U.S. DOJ regulations, “Nondiscrimination on the Basis of Disability in State and Local Government Services,” 28 C.F.R. Part 35;
 - (5) U.S. DOJ regulations, “Nondiscrimination on the Basis of Disability by Public Accommodations and in Commercial Facilities,” 28 C.F.R. Part 36;
 - (6) U.S. General Services Administration (U.S. GSA) regulations, “Accommodations for the Physically Handicapped,” 41 C.F.R. Subpart 101-19;
 - (7) U.S. EEOC, “Regulations to Implement the Equal Employment Provisions of the Americans with Disabilities Act,” 29 C.F.R. Part 1630;
 - (8) U.S. Federal Communications Commission regulations, “Telecommunications Relay Services and Related Customer Premises Equipment for the Hearing and Speech Disabled,” 47 C.F.R. Part 64, Subpart F;
 - (9) U.S. ATBCB regulations, “Electronic and Information Technology Accessibility Standards,” 36 C.F.R. Part 1194;
 - (10) FTA regulations, “Transportation for Elderly and Handicapped Persons,” 49 C.F.R. Part 609; and
 - (11) Federal civil rights and nondiscrimination directives implementing those Federal laws and regulations, except to the extent the Federal Government determines otherwise in writing.
- (h) **Drug or Alcohol Abuse - Confidentiality and Other Civil Rights Protections.** To the extent applicable, the Recipient agrees to comply with the confidentiality and civil rights protections of the Drug Abuse Office and Treatment Act of 1972, as amended, 21 U.S.C. §§ 1101 *et seq.*, the Comprehensive Alcohol Abuse and Alcoholism Prevention, Treatment and Rehabilitation Act of 1970, as amended, 42 U.S.C. §§ 4541 *et seq.*, and the Public Health Service Act of 1912, as amended, 42 U.S.C. §§ 290dd through 290dd-2, and any amendments thereto.
- (i) **Access to Services for Persons with Limited English Proficiency.** The Recipient agrees to facilitate compliance with the policies of Executive Order No. 13166, “Improving Access to Services for Persons with Limited English Proficiency,” 42 U.S.C. § 2000d-1 note, and follow applicable provisions of U.S. DOT Notice, “DOT Policy Guidance Concerning Recipients’ Responsibilities to Limited English Proficiency (LEP) Persons,” 70 *Fed. Reg.* 74087, December 14, 2005, except to the extent that FTA determines otherwise in writing.
- (j) **Environmental Justice.** The Recipient agrees to facilitate compliance with the policies of Executive Order No. 12898, “Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations,” 42 U.S.C. § 4321 note; and DOT Order 5620.3, “Department of Transportation Actions To Address Environmental Justice in Minority Populations and Low-Income Populations,” 62 *Fed. Reg.* 18377 *et seq.*, April 15, 1997, except to the extent that the Federal Government determines otherwise in writing.
- (k) **Other Nondiscrimination Laws.** The Recipient agrees to comply with applicable provisions of other Federal laws and regulations, and follow

applicable Federal directives prohibiting discrimination, except to the extent the Federal Government determines otherwise in writing.

6. **Disadvantaged Business Enterprise.** To the extent authorized by Federal law, the Recipient agrees to facilitate participation by Disadvantaged Business Enterprises (DBEs) in the Project and assures that each sub-recipient, lessee, third party contractor, or other participant at any tier of the Project will facilitate participation by DBEs in the Project to the extent applicable as follows:
 - (a) The Recipient agrees and assures that it shall comply with section 1101(b) of SAFETEA-LU, 23 U.S.C. § 101 note, and U.S. DOT regulations, "Participation by Disadvantaged Business Enterprises in Department of Transportation Financial Assistance Programs," 49 C.F.R. Part 26.
 - (b) The Recipient agrees and assures that it shall not discriminate on the basis of race, color, sex, or national origin in the award and performance of any sub-agreement, lease, third party contract, or other arrangement supported with Federal assistance derived from U.S. DOT in the administration of its DBE program and shall comply with the requirements of 49 C.F.R. Part 26. The Recipient agrees to take all necessary and reasonable steps as set forth in 49 C.F.R. Part 26 to ensure nondiscrimination in the award and administration of all sub-agreements, leases, third party contracts, and other arrangements supported with Federal assistance derived from U.S. DOT. As required by 49 C.F.R. Part 26, the Recipient's DBE program approved by U.S. DOT, if any, is incorporated by reference and made part of the Grant Agreement or Cooperative Agreement for the Project. The Recipient agrees that it has a legal obligation to implement its approved DBE program, and that its failure to carry out that DBE program shall be treated as a violation of the Grant Agreement or Cooperative Agreement for the Project and this Master Agreement. Upon notification by U.S. DOT to the Recipient of the Recipient's failure to implement its approved DBE program, U.S. DOT may impose the sanctions as set forth in 49 C.F.R. Part 26 and may, in appropriate cases, refer the matter to the appropriate Federal authorities for enforcement under 18 U.S.C. § 1001, or the Program Fraud Civil Remedies Act, 31 U.S.C. §§ 3801 *et seq.*, or both.
7. **Right of the Federal Government to Terminate.** Upon written notice, the Recipient agrees that the Federal Government may suspend or terminate all or any part of the Federal assistance to be provided for the Project if the Recipient has violated the terms of the Grant Agreement or Cooperative Agreement for the Project including this Master Agreement, or if the Federal Government determines that the purposes of the laws authorizing the Project would not be adequately served by the continuation of Federal assistance for the Project. The Recipient understands and agrees that any failure to make reasonable progress on the Project or any violation of the Grant Agreement or Cooperative Agreement for the Project, or this Master Agreement that endangers substantial performance of the Project shall provide sufficient grounds for the Federal Government to terminate the Grant Agreement or Cooperative Agreement for the Project. In general, termination of Federal assistance for the Project will not invalidate obligations properly incurred by the Recipient before the termination date to the extent those obligations cannot be canceled. If, however, the Federal Government

determines that the Recipient has willfully misused Federal assistance by failing to make adequate progress, by failing to make reasonable and appropriate use of Project property, or by failing to comply with the terms of the Grant Agreement or Cooperative Agreement for the Project including this Master Agreement, the Federal Government reserves the right to require the Recipient to refund the entire amount of Federal assistance provided for the Project or any lesser amount as the Federal Government may determine. Expiration of any Project time period established for the Project does not, by itself, constitute an expiration or termination of the Grant Agreement or Cooperative Agreement for the Project.

8. **Equal Employment Opportunity Requirements for Construction Activities.** For activities determined by the U.S. Department of Labor (U.S. DOL) to qualify as “construction,” the Recipient agrees to comply and assures the compliance of each sub-recipient, lessee, third party contractor, or other participant, at any tier of the Project, with all requirements of U.S. DOL regulations, “Office of Federal Contract Compliance Programs, Equal Employment Opportunity, Department of Labor,” 41 C.F.R. Parts 60 *et seq.*; with implementing Executive Order No. 11246, “Equal Employment Opportunity,” as amended by Executive Order No. 11375, “Amending Executive Order No. 11246 Relating to Equal Employment Opportunity,” 42 U.S.C. § 2000e note, and with other applicable EEO laws and regulations, and also agrees to follow applicable Federal directives, except as the Federal Government determines otherwise in writing.
9. **Debarment and Suspension.** The Recipient agrees to comply with applicable provisions of Executive Orders Nos. 12549 and 12689, “Debarment and Suspension,” 31 U.S.C. § 6101 note, and U.S. DOT regulations, “Non-procurement Suspension and Debarment,” 2 C.F.R. Part 1200, which adopt and supplement the provisions of U.S. Office of Management and Budget (U.S. OMB) “Guidelines to Agencies on Government-wide Debarment and Suspension (Non-procurement),” 2 C.F.R. Part 180. To the extent required by these U.S. DOT regulations and U.S. OMB guidance, the Recipient agrees to review the “Excluded Parties Listing System” at <http://epls.gov/> and to include a similar term or condition in each lower tier covered transaction, assuring that, to the extent required by the U.S. DOT regulations and U.S. OMB guidance, each sub-recipient, lessee, third party contractor, and other participant at a lower tier of the Project, will review the “Excluded Parties Listing System” at <http://epls.gov/>, and will include a similar term or condition in each of its lower tier covered transactions.
10. **Buy America.** The Recipient agrees to comply with 49 U.S.C. § 5323(j) and FTA regulations, “Buy America Requirements,” 49 C.F.R. Part 661, and any amendments thereto.
11. **Changes in Project Performance (i.e., Disputes, Breaches, Defaults, or Litigation).** The Recipient agrees to notify FTA immediately, in writing, of any change in local law, conditions (including its legal, financial, or technical capacity), or any other event that may adversely affect the Recipient’s ability to perform the Project in accordance with the terms of the Grant Agreement or Cooperative Agreement for the Project and this Master Agreement. The Recipient also agrees to notify FTA immediately, in writing, of any current or prospective major dispute, breach, default, or litigation that may adversely affect the Federal Government’s interests in the Project or the Federal Government’s administration or enforcement of Federal laws or regulations; and agrees to inform FTA, also in

writing, before naming the Federal Government as a party to litigation for any reason, in any forum. At a minimum, the Recipient agrees to provide each notice to FTA required by this subsection of this Master Agreement to the FTA Regional Counsel for the Region in which the Recipient operates its public transportation system or implements the Project.

12. **Lobbying Restrictions.** The Recipient agrees that:

- (a) In compliance with 31 U.S.C. § 1352(a), it will not use Federal assistance to pay the costs of influencing any officer or employee of a Federal agency, Member of Congress, officer of Congress or employee of a member of Congress, in connection with making or extending the Grant Agreement or Cooperative Agreement;
- (b) In addition, it will comply with other applicable Federal laws and regulations prohibiting the use of Federal assistance for activities designed to influence Congress or a State legislature with respect to legislation or appropriations, except through proper, official channels; and
- (c) It will comply, and will assure the compliance of each sub-recipient, lessee, third party contractor, or other participant at any tier of the Project with U.S. DOT regulations, “New Restrictions on Lobbying,” 49 C.F.R. Part 20, modified as necessary by 31 U.S.C. § 1352, as amended.

13. **National Environmental Policy.** Federal assistance is contingent upon the Recipient’s facilitating FTA’s compliance with all applicable requirements and implementing regulations of the National Environmental Policy Act of 1969, as amended (NEPA), 42 U.S.C. §§ 4321 through 4335 (as restricted by 42 U.S.C. § 5159, if applicable); Executive Order No. 11514, as amended, “Protection and Enhancement of Environmental Quality,” 42 U.S.C. § 4321 note; FTA statutory requirements at 49 U.S.C. § 5324(b); U.S. Council on Environmental Quality regulations pertaining to compliance with NEPA, 40 C.F.R. Parts 1500 through 1508; and joint FHWA/FTA regulations, “Environmental Impact and Related Procedures,” 23 C.F.R. Part 771 and 49 C.F.R. Part 622, and other applicable Federal environmental protection regulations that may be promulgated at a later date. The Recipient agrees to comply with the applicable provisions of 23 U.S.C. § 139 pertaining to environmental procedures, and, as applicable, 23 U.S.C. § 326, pertaining to State responsibility for categorical exclusions, in accordance with the provisions of joint FHWA/FTA final guidance, “SAFETEA-LU Environmental Review Process (Public Law 109-59),” 71 *Fed. Reg.* 66576 *et seq.*, November 15, 2006, and any applicable Federal directives that may be issued at a later date, except to the extent that FTA determines otherwise in writing.

14. **Air Quality.** Except to the extent the Federal Government determines otherwise in writing, the Recipient agrees to comply with all applicable Federal laws and regulations and follow applicable Federal directives implementing the Clean Air Act, as amended, 42 U.S.C. §§ 7401 through 7671q. Specifically:

- (a) The Recipient agrees to comply with the applicable requirements of subsection 176(c) of the Clean Air Act, 42 U.S.C. § 7506(c); with U.S. EPA regulations, “Determining Conformity of Federal Actions to State or Federal Implementation Plans,” 40 C.F.R. Part 93, Subpart A; and with any other applicable Federal conformity regulations that may be promulgated at a later date. To support the requisite air quality conformity finding for the Project, the Recipient agrees to implement each air quality

mitigation or control measure incorporated in the applicable documents accompanying the approval of the Project. The Recipient further agrees that any Project identified in an applicable State Implementation Plan (SIP) as a Transportation Control Measure will be wholly consistent with the design concept and scope of the Project described in the SIP.

- (b) U.S. EPA also imposes requirements implementing the Clean Air Act, as amended, that may apply to public transportation operators, particularly operators of large public transportation bus fleets. Accordingly, to the extent they apply to the Project, the Recipient agrees to comply with U.S. EPA regulations, "Control of Air Pollution from Mobile Sources," 40 C.F.R. Part 85; U.S. EPA regulations, "Control of Air Pollution from New and In-Use Motor Vehicles and New and In-Use Motor Vehicle Engines," 40 C.F.R. Part 86; and U.S. EPA regulations "Fuel Economy of Motor Vehicles," 40 C.F.R. Part 600, and any revisions thereto.
- (c) The Recipient agrees to comply with the notice of violating facility provisions of section 306 of the Clean Air Act, as amended, 42 U.S.C. § 7414, and facilitate compliance with Executive Order No. 11738, "Administration of the Clean Air Act and the Federal Pollution Control Act with Respect to Federal Contracts, Grants, or Loans," 42 U.S.C. § 7606 note.

15. **Clean Water.** Except to the extent the Federal Government determines otherwise in writing, the Recipient agrees to comply with all applicable Federal laws and regulations and follow applicable Federal directives implementing the Clean Water Act, as amended, 33 U.S.C. §§ 1251 through 1377. Specifically:

- (a) The Recipient agrees to protect underground sources of drinking water in compliance with the Safe Drinking Water Act of 1974, as amended, 42 U.S.C. §§ 300f through 300j-6.
- (b) The Recipient agrees to comply with the notice of violating facility provisions of section 508 of the Clean Water Act, as amended, 33 U.S.C. § 1368, and facilitate compliance with Executive Order No. 11738, "Administration of the Clean Air Act and the Federal Water Pollution Control Act with Respect to Federal Contracts, Grants, or Loans," 42 U.S.C. § 7606 note.

(When Applicable)

16. **Cargo Preference** - Use of United States-Flag Vessels. To the extent applicable, the Recipient agrees to comply with 46 U.S.C. § 55305 and U.S. Maritime Administration regulations, "Cargo Preference - U.S.-Flag Vessels," 46 C.F.R. Part 381.

17. **Fly America.** The Recipient agrees that the Federal Government will not participate in the costs of international air transportation of any individuals involved in or property acquired for the Project unless that air transportation is provided by U.S.-flag air carriers to the extent such service is available, in compliance with section 5 of the International Air Transportation Fair Competitive Practices Act of 1974, as amended, 49 U.S.C. § 40118, and U.S. GSA regulations, "Use of United States Flag Air Carriers," 41 C.F.R. §§ 301-10.131 through 301-10.143.

18. **Section 24. Employee Protections.**

- (a) Construction Activities. The Recipient agrees to comply, and assures the compliance of each sub-recipient, lessee, third party contractor, and other

participant at any tier of the Project, with the following Federal laws and regulations providing protections for construction employees:

- (1) Davis-Bacon Act, as amended, 40 U.S.C. §§ 3141 *et seq.*, pursuant to FTA enabling legislation requiring compliance with the Davis-Bacon Act at 49 U.S.C. § 5333(a), and implementing U.S. DOL regulations, “Labor Standards Provisions Applicable to Contracts Governing Federally Financed and Assisted Construction (also Labor Standards Provisions Applicable to Non-construction Contracts Subject to the Contract Work Hours and Safety Standards Act),” 29 C.F.R. Part 5;
- (2) Contract Work Hours and Safety Standards Act, as amended, 40 U.S.C. §§ 3701 *et seq.*, specifically, the wage and hour requirements of section 102 of that Act at 40 U.S.C. § 3702, and implementing U.S. DOL regulations, “Labor Standards Provisions Applicable to Contracts Governing Federally Financed and Assisted Construction (also Labor Standards Provisions Applicable to Non-construction Contracts Subject to the Contract Work Hours and Safety Standards Act),” 29 C.F.R. Part 5; and the safety requirements of section 107 of that Act at 40 U.S.C. § 3704, and implementing U.S. DOL regulations, “Safety and Health Regulations for Construction,” 29 C.F.R. Part 1926; and
- (3) Copeland “Anti-Kickback” Act, as amended, 18 U.S.C. § 874 and 40 U.S.C. § 3145, and implementing U.S. DOL regulations, “Contractors and Subcontractors on Public Building or Public Work Financed in Whole or in part by Loans or Grants from the United States,” 29 C.F.R. Part 3.

19. **Activities Not Involving Construction.** The Recipient agrees to comply, and assures the compliance of each sub-recipient, lessee, third party contractor, and other participant at any tier of the Project, with the employee protection requirements for non-construction employees of the Contract Work Hours and Safety Standards Act, as amended, 40 U.S.C. §§ 3701 *et seq.*, in particular with the wage and hour requirements of section 102 of that Act at 40 U.S.C. § 3702, and with implementing U.S. DOL regulations, “Labor Standards Provisions Applicable to Contracts Governing Federally Financed and Assisted Construction (also Labor Standards Provisions Applicable to Non-construction Contracts Subject to the Contract Work Hours and Safety Standards Act),” 29 C.F.R. Part 5.

20. **Public Transportation Employee Protective Arrangements.** If the Grant Agreement or Cooperative Agreement for the Project indicates that public transportation employee protective arrangements required by U.S. DOL apply to public transportation operations performed in connection with the Project, the Recipient agrees to comply with the following requirements:

- (a) **Standard Public Transportation Employee Protective Arrangements.** To the extent that the Project involves public transportation operations and to the extent required by Federal law, the Recipient agrees to implement the Project in accordance with the terms and conditions that the U.S. Secretary of Labor has determined to be fair and equitable to protect the interests of any employees affected by the Project and that comply with the requirements of 49 U.S.C. § 5333(b), in accordance with U.S. DOL guidelines, “Section 5333(b), Federal Transit Law,” 29 C.F.R. Part 215,

and any amendments thereto. These terms and conditions are identified in U.S. DOL's certification of public transportation employee protective arrangements to FTA, the date of which appears in the Grant Agreement or Cooperative Agreement for the Project. The Recipient agrees to implement the Project in accordance with the conditions stated in that U.S. DOL certification. That certification and any documents cited therein are incorporated by reference and made part of the Grant Agreement or Cooperative Agreement for the Project. The requirements of this Paragraph 24.d(1) of this Master Agreement do not apply to Projects for elderly individuals or individuals with disabilities authorized by 49 U.S.C. § 5310(a)(2) or subsection 3012(b) of SAFETEA-LU, Projects for nonurbanized areas authorized by 49 U.S.C. § 5311; or Projects for the over-the-road bus accessibility program authorized by section 3038 of TEA-21, as amended by section 3039 of SAFETEA-LU, 49 U.S.C. § 5310 note. Separate requirements for those Projects are set forth in Paragraphs 24.d(2), (3), and (4), respectively, of this Master Agreement.

- (b) Public Transportation Employee Protective Arrangements for the Elderly Individuals and Individuals with Disabilities Formula Program and for the Elderly Individuals and Individuals with Disabilities Formula Program Pilot Program. To the extent that the U.S. Secretary of Transportation has determined or determines in the future that employee protective arrangements required by 49 U.S.C. § 5333(b) are necessary or appropriate for a governmental authority sub-recipient participating in a Project authorized by 49 U.S.C. § 5310(b)(2) or subsection 3012(b) of SAFETEA-LU, 49 U.S.C. § 5310 note, the Recipient agrees to carry out the Project in compliance with the terms and conditions determined by the U.S. Secretary of Labor necessary to comply with the requirements of 49 U.S.C. § 5333(b), in accordance with U.S. DOL guidelines, "Section 5333(b), Federal Transit Law," at 29 C.F.R. Part 215, and any amendments thereto. These terms and conditions, if any, are identified in the U.S. DOL's certification of public transportation employee protective arrangements to FTA, the date of which appears in the Grant Agreement. The Recipient agrees to implement the Project in compliance with the conditions stated in that U.S. DOL certification, to the extent that certification is required. Any U.S. DOL certification that may be provided and any documents cited therein are incorporated by reference and made part of the Grant Agreement.
- (c) Public Transportation Employee Protective Arrangements for Projects in Nonurbanized Areas Authorized by 49 U.S.C. § 5311. The Recipient agrees to comply with the terms and conditions of the Special Warranty for the Nonurbanized Area Program that is most current as of the date of execution of the Grant Agreement or Cooperative Agreement for the Project, and any alternative comparable arrangements specified by U.S. DOL for application to the Recipient's project, in accordance with U.S. DOL guidelines, "Section 5333(b), Federal Transit Law," 29 C.F.R. Part 215, and any revisions thereto. Any U.S. DOL Special Warranty that may be provided and any documents cited therein are incorporated by reference and made part of the Grant Agreement.

- (d) **Employee Protective Arrangements for Projects Financed by the Over-the-Road Bus Accessibility Program.** The Recipient agrees to comply with the terms and conditions of the Special Warranty for the Over-the-Road Bus Accessibility Program that is most current as of the date of execution of the Grant Agreement or Cooperative Agreement for the Project, and any alternative comparable arrangements specified by U.S. DOL for application to the Recipient's project, in accordance with U.S. DOL guidelines, "Section 5333(b), Federal Transit Law," 29 C.F.R. Part 215, and any revisions thereto. Any U.S. DOL Special Warranty that may be provided and any documents cited therein are incorporated by reference and made part of the Grant Agreement.

21. **Seismic Safety.** The Recipient agrees to comply with the Earthquake Hazards Reduction Act of 1977, as amended, 42 U.S.C. §§ 7701 *et seq.*, in accordance with Executive Order No. 12699, "Seismic Safety of Federal and Federally-Assisted or Regulated New Building Construction," 42 U.S.C. § 7704 note, and comply with implementing U.S. DOT regulations, "Seismic Safety," 49 C.F.R. Part 41 (specifically, 49 C.F.R. § 41.117).

Patent Rights and Rights in Data and Copyrights only apply if R&D is involved.

22. **Patent Rights.**

- (a) **General.** If any invention, improvement, or discovery of the Recipient or of any sub-recipient, lessee, third party contractor, or other participant at any tier of the Project is conceived or first actually reduced to practice in the course of or under the Project, and that invention, improvement, or discovery is patentable under the laws of the United States of America or any foreign country, the Recipient agrees to notify FTA immediately and provide a detailed report in a format satisfactory to FTA.
- (b) **Federal Rights.** The Recipient agrees that its rights and responsibilities, and those of each sub-recipient, lessee, third party contractor, or other participant at any tier of the Project, pertaining to that invention, improvement, or discovery will be determined in accordance with applicable Federal laws and regulations, including any waiver thereof. Absent a determination in writing to the contrary by the Federal Government, the Recipient agrees to transmit to FTA those rights due the Federal Government in any invention, improvement, or discovery resulting from that sub-agreement, third party contract, third party subcontract, or arrangement, as specified in 35 U.S.C. §§ 200 *et seq.*, and U.S. Department of Commerce regulations, "Rights to Inventions Made by Nonprofit Organizations and Small Business Firms Under Government Grants, Contracts and Cooperative Agreements," 37 C.F.R. Part 401, irrespective of the status of the Recipient, sub-recipient, lessee, third party contractor or other participant in the Project (*i.e.*, a large business, small business, State government, State instrumentality, local government, Indian tribe, nonprofit organization, institution of higher education, or individual).
- (c) **License Fees and Royalties.** FTA considers income earned from license fees and royalties for patents, patent applications, and inventions produced under the Project to be program income. Except to the extent FTA determines otherwise in writing, as provided in 49 C.F.R. Parts 18 and 19, the Recipient has no obligation to the Federal Government with

respect to that program income, apart from compliance with 35 U.S.C. §§ 200 *et seq.*, which applies to patent rights developed under a research project.

23. Rights in Data and Copyrights.

- (a) **Definition.** The term “subject data,” as used in this Section 18 of this Master Agreement means recorded information, whether or not copyrighted, that is delivered or specified to be delivered under the Grant Agreement or Cooperative Agreement for the Project. Examples include, but are not limited to: computer software, standards, specifications, engineering drawings and associated lists, process sheets, manuals, technical reports, catalog item identifications, and related information. “Subject data” do not include financial reports, cost analyses, or other similar information used for Project administration.
- (b) **General.** The following restrictions apply to all subject data first produced in the performance of the Grant Agreement or Cooperative Agreement for the Project:
 - (1) Except for its own internal use, the Recipient may not publish or reproduce subject data in whole or in part, or in any manner or form, nor may the Recipient authorize others to do so, without the prior written consent of the Federal Government, unless the Federal Government has previously released or approved the release of such data to the public.
 - (2) The restrictions on publication of Paragraph 18.b(1) of this Master Agreement, however, do not apply to a Grant Agreement or Cooperative Agreement with an institution of higher learning.
- (c) **Federal Rights in Data and Copyrights.** The Recipient agrees to provide to the Federal Government a royalty-free, non-exclusive, and irrevocable license to reproduce, publish, or otherwise use, and to authorize others to use, for Federal Government purposes the subject data described in this Subsection 18.c of this Master Agreement. As used herein, “for Federal Government purposes,” means use only for the direct purposes of the Federal Government. Without the copyright owner’s consent, the Federal Government may not provide or otherwise extend to other parties the Federal Government’s license to:
 - (1) Any subject data developed under the Grant Agreement or Cooperative Agreement for the Project, or under a sub-agreement, lease, third party contract or other arrangement at any tier of the Project, supported with Federal assistance derived from the Grant Agreement or Cooperative Agreement for the Project, whether or not a copyright has been obtained; and
 - (2) Any rights of copyright to which a Recipient, sub-recipient, lessee, third party contractor, or other participant at any tier of the Project purchases ownership using Federal assistance.
- (d) **Special Federal Rights in Data for Research, Development, Demonstration, and Special Studies Projects.** In general, FTA’s purpose in providing Federal assistance for a research, development, demonstration, or special studies Project is to increase transportation knowledge, rather than limit the benefits of the Project to Project participants. Therefore, when the Project is completed, the Recipient

agrees to provide a Project report that FTA may publish or make available for publication on the Internet. In addition, the Recipient agrees to provide other reports pertaining to the Project that FTA may request. The Recipient agrees to identify clearly any specific confidential, privileged, or proprietary information it submits to FTA. In addition, except to the extent that FTA determines otherwise in writing, the Recipient of Federal assistance to support a research, development, demonstration, or a special studies Project agrees that, in addition to the rights in data and copyrights that it must provide to the Federal Government as set forth in Subsection 18.c of this Master Agreement, FTA may make available to any FTA recipient, sub-recipient, third party contractor, third party subcontractor or other participant at any tier of the Project, either FTA's license in the copyright to the subject data or a copy of the subject data. If the Project is not completed for any reason whatsoever, all data developed under the Project shall become subject data as defined in Subsection 18.a of this Master Agreement and shall be delivered as the Federal Government may direct. This Subsection 18.d, however, does not apply to adaptations of automatic data processing equipment or programs for the Recipient's use when the costs thereof are financed with Federal assistance through an FTA capital program.

- (e) License Fees and Royalties. FTA considers income earned from license fees and royalties for copyrighted material, or trademarks produced under the Project to be program income. Except to the extent FTA determines otherwise in writing, as provided in 49 C.F.R. Parts 18 and 19, the Recipient has no obligation to the Federal Government with respect to that program income, apart from compliance with 35 U.S.C. §§ 200 *et seq.*, which applies to patent rights developed under a research project.
- (f) Hold Harmless. Except as prohibited or otherwise limited by State law or except to the extent that FTA determines otherwise in writing, upon request by the Federal Government, the Recipient agrees to indemnify, save, and hold harmless the Federal Government and its officers, agents, and employees acting within the scope of their official duties against any liability, including costs and expenses, resulting from any willful or intentional violation by the Recipient of proprietary rights, copyrights, or right of privacy, arising out of the publication, translation, reproduction, delivery, use, or disposition of any data furnished under the Project. The Recipient shall not be required to indemnify the Federal Government for any such liability caused by the wrongful acts of Federal employees or agents.
- (g) Restrictions on Access to Patent Rights. Nothing in Section 18 of this Master Agreement pertaining to rights in data shall either imply a license to the Federal Government under any patent or be construed to affect the scope of any license or other right otherwise granted to the Federal Government under any patent.
- (h) Data Developed Without Federal Funding or Support. In connection with the Project, the Recipient may find it necessary to provide data to FTA developed without any Federal funding or support by the Federal Government. The requirements of Subsections 18.b, 18.c, and 18.d of this Master Agreement do not apply to data developed without Federal

funding or support by the Federal Government, even though that data may have been used in connection with the Project. Nevertheless, the Recipient understands and agrees that the Federal Government will not be able to protect data from unauthorized disclosure unless that data is clearly marked “Proprietary” or “Confidential.”

- (i) **Requirements to Release Data.** To the extent required by U.S. DOT regulations, “Uniform Administrative Requirements for Grants and Agreements with Institutions of Higher Education, Hospitals, and Other Non-Profit Organizations,” at 49 C.F.R. § 19.36(d), or other applicable Federal laws or Federal regulations, the Recipient understands and agrees that the data and information it submits to the Federal Government may be required to be released in accordance with the Freedom of Information Act (or another Federal law or Federal regulation providing access to such records).

- 24. **Energy Conservation.** The Recipient agrees to comply with applicable mandatory energy standards and policies of State energy conservation plans under the Energy Policy and Conservation Act, as amended, 42 U.S.C. §§ 6321 *et seq.*, except to the extent that the Federal Government determines otherwise in writing. As applicable, the Recipient agrees to perform an energy assessment for any building constructed, reconstructed, or modified with FTA assistance, in compliance with FTA regulations, “Requirements for Energy Assessments,” 49 C.F.R. Part 622, Subpart C.
- 25. **Special Notification Requirements for States.** To the extent required by Federal law, the State agrees that, in administering any Federal assistance Program or Project supported by the Grant Agreement or Cooperative Agreement, any request for proposals, solicitation, grant application, form, notification, press release, or other publication involving the distribution of FTA assistance for the Program or the Project shall indicate that FTA is the Federal agency that is providing the Federal assistance, the Catalog of Federal Domestic Assistance Number of the program from which the Federal assistance is authorized, as may be applicable, and the amount of Federal assistance FTA provided.
- 26. **National Intelligent Transportation Systems Architecture and Standards.** To the extent applicable, the Recipient agrees to conform to the National Intelligent Transportation Systems (ITS) Architecture and Standards as required by SAFETEA-LU § 5307(c), 23 U.S.C. § 512 note, and follow the provisions of FTA Notice, “FTA National ITS Architecture Policy on Transit Projects,” 66 *Fed. Reg.* 1455 *et seq.*, January 8, 2001, and any other implementing directives FTA may issue at a later date, except to the extent FTA determines otherwise in writing.
- 27. **Access for Individuals with Disabilities.** The Recipient agrees to comply with 49 U.S.C. § 5301(d), which states the Federal policy that elderly individuals and individuals with disabilities have the same right as other individuals to use public transportation services and facilities, and that special efforts shall be made in planning and designing those services and facilities to implement transportation accessibility rights for elderly individuals and individuals with disabilities. The Recipient also agrees to comply with all applicable provisions of section 504 of the Rehabilitation Act of 1973, as amended, 29 U.S.C. § 794, which prohibits discrimination on the basis of disability in the administration of programs or

activities receiving Federal financial assistance; with the Americans with Disabilities Act of 1990 (ADA), as amended, 42 U.S.C. §§ 12101 *et seq.*, which requires that accessible facilities and services be made available to individuals with disabilities; with the Architectural Barriers Act of 1968, as amended, 42 U.S.C. §§ 4151 *et seq.*, which requires that buildings and public accommodations be accessible to individuals with disabilities; and with other laws and amendments thereto pertaining to access for individuals with disabilities that may be applicable. In addition, the Recipient agrees to comply with applicable implementing Federal regulations, and any later amendments thereto, and agrees to follow applicable Federal implementing directives, except to the extent FTA approves otherwise in writing. Among those regulations and directives are:

- (a) U.S. DOT regulations, "Transportation Services for Individuals with Disabilities (ADA)," 49 C.F.R. Part 37;
- (b) U.S. DOT regulations, "Nondiscrimination on the Basis of Handicap in Programs and Activities Receiving or Benefiting from Federal Financial Assistance," 49 C.F.R. Part 27;
- (c) Joint U.S. Architectural and Transportation Barriers Compliance Board (U.S. ATBCB)/U.S. DOT regulations, "Americans With Disabilities (ADA) Accessibility Specifications for Transportation Vehicles," 36 C.F.R. Part 1192 and 49 C.F.R. Part 38;
- (d) U.S. DOJ regulations, "Nondiscrimination on the Basis of Disability in State and Local Government Services," 28 C.F.R. Part 35;
- (e) U.S. DOJ regulations, "Nondiscrimination on the Basis of Disability by Public Accommodations and in Commercial Facilities," 28 C.F.R. Part 36;
- (f) U.S. General Services Administration (U.S. GSA) regulations, "Accommodations for the Physically Handicapped," 41 C.F.R. Subpart 101-19;
- (g) U.S. EEOC, "Regulations to Implement the Equal Employment Provisions of the Americans with Disabilities Act," 29 C.F.R. Part 1630;
- (h) U.S. Federal Communications Commission regulations, "Telecommunications Relay Services and Related Customer Premises Equipment for the Hearing and Speech Disabled," 47 C.F.R. Part 64, Subpart F;
- (i) U.S. ATBCB regulations, "Electronic and Information Technology Accessibility Standards," 36 C.F.R. Part 1194;
- (j) FTA regulations, "Transportation for Elderly and Handicapped Persons," 49 C.F.R. Part 609; and
- (k) Federal civil rights and nondiscrimination directives implementing those Federal laws and regulations, except to the extent the Federal Government determines otherwise in writing.

C. To the extent applicable, the Recipient agrees to comply with the following third party procurement provisions:

1. **Federal Standards.** The Recipient agrees to comply with applicable third party procurement requirements of 49 U.S.C. chapter 53 and Federal laws in effect now or subsequently enacted; with applicable U.S. DOT third party procurement regulations at 49 C.F.R. § 18.36 or 49 C.F.R. §§ 19.40 through 19.48, and with other applicable Federal regulations pertaining to third party procurements and later amendments thereto. The Recipient also agrees to follow the provisions of

the most recent edition and revisions of FTA Circular 4220.1F, “Third Party Contracting Guidance,” except to the extent FTA determines otherwise in writing. The Recipient agrees that it may not use FTA assistance to support its third party procurements unless its compliance with Federal laws and regulations is satisfactory. Although the FTA “Best Practices Procurement Manual” provides additional third party contracting information, the Recipient understands and agrees that the FTA “Best Practices Procurement Manual” may omit certain Federal requirements applicable to specific third party contracts.

- D. The Contractor shall comply with the specific requirements of the Federal Transit Administration (Section 00486.0 – Disadvantaged Business Enterprise (DBE) Requirements).

Project Specific Monthly Report

Human Relations Department - City of Kansas City Missouri

Report Date:	Reporting Period:	Project Description:	
Project Name:	Contractor:	Contract Awarded Date:	
City Project Number:	Contractor Address:	City Contract Number:	
Project Address:		City Vendor ID:	
	Contact Person/Phone:	Contractor Report <input type="checkbox"/>	Subcontractor Report <input type="checkbox"/>
E-mail Address:		Final Cumulative Report: <input type="checkbox"/> Yes <input type="checkbox"/> No	

Report the total monthly hours of work performed by all workers on the City Construction Contract. Enter the total hours on all lines and in all columns.
Reported workforce hours should be based on payroll records.

JOB CATEGORIES	OVERALL TOTAL (Sum of all Columns, A thru F Male & Female)	A Total Hours White Employees		B Total Hours Black Employees		C Total Hours Hispanic Employees		D Total Hours Asian/Pacific Islander		E Total Hours Native American Employee		F Total Hours Other/Unknown Race Employee		G KCMO Resident Hours
		M	F	M	F	M	F	M	F	M	F	M	F	Total #
		Foreman/Supervisor												
Asbestos Worker Journeyman														
Asbestos Worker Apprentice														
Boilermaker Journeyman														
Boilermaker Apprentice														
Bricklayer Journeyman														
Bricklayer Apprentice														
Carpenter Journeyman														
Carpenter Apprentice														
Cement Mason Journeyman														
Cement Mason														
Electrician Journeyman														
Electrician Apprentice														
Elevator Constructor Journeyman														
Elevator Constructor Apprentice														
Glazier Journeyman														
Glazier Apprentice														
Iron Worker Journeyman														
Iron Worker Apprentice														
Laborer Journeyman														
Laborer Apprentice														
Operating Engineer Journeyman														
Operating Engineer Apprentice														
Painter Journeyman														
Painter Apprentice														
Pipe Fitter/Plumber Journeyman														
Pipe Fitter/Plumber Apprentice														
Plasterer Journeyman														
Plasterer Apprentice														
Roofer Journeyman														
Roofer Apprentice														
Sheet Metal Journeyman														
Sheet Metal Apprentice														
Sprinkler Fitter														
Sprinkler Fitter Apprentice														
Truck Driver Journeyman														
Truck Driver Apprentice														
Welder Journeyman														
Welder Apprentice														
Other														
Monthly Total Hours														-
Total % of Monthly Hrs.														

Contractor shall submit report by the 15th of each month.													
Phillip Yelder, Director Human Relations Department													
414 E. 12th Street, 4th Floor Kansas City, MO 64106													
Phone: 816-513-1836 Email: HRDcontractcompliance@kcmo.org													
										Report Submitted By: _____			
										Date: _____			

Company-Wide Workforce Monthly Report

Human Relations Department - City of Kansas City, Missouri

Report Date:		Reporting Period:		Contract Awarded Date:	
Contractor:				City Vendor ID:	
Contact Person/Phone:		Contractor Address:		Contractor Report <input type="checkbox"/>	Subcontractor Report <input type="checkbox"/>
E-mail Address:		Have you hired any new construction workers this month?	<input type="checkbox"/> Yes #: <input type="checkbox"/> No	Final Cumulative Report: <input type="checkbox"/> Yes <input type="checkbox"/> No	

Report total of all hours of work performed company-wide on all projects in the KCMO Metropolitan Statistical Area (MSA). Enter the total hours on all lines and in all columns. Workforce hours should be based on payroll records.

JOB CATEGORIES	OVERALL TOTAL (Sum of all Columns, A thru F Male & Female)	A Total Hours White Employees		B Total Hours Black Employees		C Total Hours Hispanic Employees		D Total Hours Asian/Pacific Islander		E Total Hours Native American Employee		F Total Hours Other/Unknown Race Employee		G KCMO Resident Hours	
		M	F	M	F	M	F	M	F	M	F	M	F	Total #	
		Foreman/Supervisor													
Asbestos Worker Journeyman															
Asbestos Worker Apprentice															
Boilermaker Journeyman															
Boilermaker Apprentice															
Bricklayer Journeyman															
Bricklayer Apprentice															
Carpenter Journeyman															
Carpenter Apprentice															
Cement Mason Journeyman															
Cement Mason Apprentice															
Electrician Journeyman															
Electrician Apprentice															
Elevator Constructor Journeyman															
Elevator Constructor Apprentice															
Glazier Journeyman															
Glazier Apprentice															
Iron Worker Journeyman															
Iron Worker Apprentice															
Laborer Journeyman															
Laborer Apprentice															
Operating Engineer Journeyman															
Operating Engineer Apprentice															
Painter Journeyman															
Painter Apprentice															
Pipe Fitter/Plumber Journeyman															
Pipe Fitter/Plumber Apprentice															
Plasterer Journeyman															
Plasterer Apprentice															
Roofer Journeyman															
Roofer Apprentice															
Sheet Metal Journeyman															
Sheet Metal Apprentice															
Sprinkler Fitter															
Sprinkler Fitter Apprentice															
Truck Driver Journeyman															
Truck Driver Apprentice															
Welder Journeyman															
Welder Apprentice															
Other															
Total Monthly Hours															
Total % of Hours															

Contractor shall submit report by the 15th of each month.													
Phillip Yelder, Director Human Relations Department 414 E. 12th Street, 4th Floor, Kansas City, MO 64106 Phone: 816-513-1836 Email: HRDcontractcompliance@kcmo.org										Report Submitted By: _____			
										Date: _____			



RFQ015 – Structure Modifications

Attachment B – Pre-Qualification / Evidence of
Competency To Perform

December 18th, 2013



KANSAS CITY STREETCAR

ATTACHMENT B

Pre-Qualification / Evidence of Competency to Perform

City of Kansas City – Structure Modifications

December 18th, 2013

Introduction

This document (Attachment B) serves as a *Pre-Qualification / Evidence of Competency* to perform the *Structure Modification* scope of work on the Kansas City Streetcar Project. As stated in the solicitation letter, pre-qualification ensures that the successful subcontractor will adequately understand, manage, staff, bond and perform the technical structural modification portion of the project. It is necessary to select a pre-qualified list of subcontractors due to the project's complex design and multiple phases of work, and the highly technical work that will be required to be performed. Also of note are the strict schedule requirements. There will be several other scopes of work occurring simultaneously including (but not limited to) private utility relocations (gas, power, street lighting, telecom, etc.), trackway excavation and construction, ductbank construction, and other phases and scopes of work, all of which will require close coordination with all parties.

The sensitive nature of working adjacent to downtown businesses needs to be taken into account during all phases of the work from the planning phase to the final punchlist work. The coordination of community impact, Union Station, KCTRR railroad, and MoDOT coordination, and effective and safe pedestrian controls is of the utmost importance to the project and the Owner.

The subcontractor should also provide opportunities and complete the outreach to DBE subcontractors. The Project has a goal of 24% DBE participation overall and it should be the understanding by the bidder this 24% goal shall pertain to all phases of work, including this portion of the work. KCSCJV is committed to assisting both the bidders, and the DBE contractors wishing to perform work on the Project. Additionally KCSCJV will provide resources, information, and assistance to assist in identifying scopes and portions of work on the Project for DBE contractors.

Emphasis should also be made on the work as it pertains to the overall project schedule. This means the successful bidder should, at a minimum, have the necessary equipment, management, and field staff available to support the project at all times.

Below find the 'Evidence of Competency to Perform' specifications which are similar to what would be provided in a City of Kansas City bid package. The below **BOLDED** text includes notations and additional clarifications provided by KCSC, and/or additional items requested for this scope specific document. Additionally, failure to provide a complete package with information and documentation may result in disqualification. Some sections have maximum number of pages, please follow these. All pages are defined as one (1) single-sided 8.5" x 11" sheet of paper, minimum size 12 fonts.



Responses will be reviewed for completeness and content by a panel that will include (but will not be limited to) persons from the City of Kansas City and Project Management from KCSCJV. Pre-qualified firms will then provide pricing for the work within the bid package. Additionally, a scoring matrix will be utilized in the pre-qualification process. The categories will be based on **Safety Program, DBE Program, and Key Personnel / Experience**. Points will be awarded based on evaluation by KCSCJV and KCMO. Please reference further down in this document for an example of the scoring matrix. There will be a minimum score of 45 points required to be pre-qualified for bidding the work. The maximum possible points will be 60.

Each subcontractor that desires to bid on the water construction scope of work shall furnish satisfactory evidence of Bidder's competency to perform the proposed work. Such evidence of competency shall consist of the following:

1. Experience Reference Summary for similar projects performed within the past 5 years, including reference information. **[Maximum 3 pages total for a-d below]** **[Key Personnel / Experience Scoring – 25 pts]**
 - a. **Information regarding previous bridge constructions or modifications similar in scope.**
 - b. **Relevant experience working around KCTRR and other railroad systems.**
 - c. **Relevant experience working above active interstates or major roadways.**
 - d. **Relative experience with MoDOT and KCMO projects.**
 - e. Identify the following Key Personnel proposed for the Project. (NOTE: Key Personnel must be committed to the Project for its duration, and may not be removed or substituted without KCMO's prior written consent.) **[Maximum 3 pages total for all items below]**
 - (1) Project Manager
 - (2) On-Site Field Superintendent
 - (3) Safety Officer
 - (4) Project Engineer
 - (a) For each of the Key Personnel, provide the following background information.
 - Years of employment with current employer
 - City of residence
 - Identify any other projects this person will be involved with concurrently with the Project, and state the time commitment for the Project and each other project
 - Discuss professional registrations, education, certifications, and credentials held by this person that are applicable to the Project
 - f. Discuss generally the tasks involved in the Project: **[Maximum 3 pages total for items below]**
 - (1) Illustrate clearly and concisely the understanding of the technical elements that must be addressed for successful completion of the Project.
 - (2) Describe key issues that might affect the Project schedule and how Bidder proposes to address them.



2. DBE / Workforce Program – A 24% DBE Goal, 10% Minority Workforce and 2% Female Workforce are required. [Maximum 2 pages] [DBE Program Scoring – 15 pts]

- a. Provide a listing of key DBE/MBE/WBE subcontractors and the proposed scopes of work they would be performing.
- b. MBE / WBE past project performance and compliance with participation goals in comparable size commercial projects.

3. Summary of the Project Safety Plan for the Project [Maximum 3 pages] [Safety Program Scoring – 20 pts]

- a. Describe how Bidder proposes to address any unique safety issues for the Project
- b. Describe your safety record and environmental compliance record along with your Firm's OSHA reportable accident rates on recent comparable size projects
- c. Statement of Bidder's Experience Modification Ratio (EMR)
- d. Discuss Bidder's understanding of the traffic control required for the Project, if applicable, and how traffic control will impact the Project schedule. Discuss any major traffic control issues that need to be addressed and Bidder's proposed solutions.
- e. Identify any other special issues or problems that are likely to be encountered. Outline the manner in which Bidder suggests resolving them.
- f. Outline key community relations issues and how they might be resolved **and coordinated with KCSCJV Public Involvement Officer.**
- g. Describe any difficulties Bidder anticipates encountering in serving the City, in light of the City's status as a municipality and public entity. Explain how Bidder plans to manage them.

4. Summary of Bidder's Quality Assurance/Quality Control Plan for this project. [Maximum 2 pages]

5. Statement regarding all work performed two (2) years immediately preceding the date of the Bid, that contains either (a) a contract by contract listing of any written notices of violations of any federal or state prevailing wage statute in which prevailing wage penalties were assessed against the Bidder or paid by the Bidder; or (b) a statement that there have been no such written notices of violations or such penalties assessed; and a statement that Bidder is current on payment of Federal and State income tax withholdings and unemployment insurance payments. **[No page limit]**

6. Statement regarding all work performed two (2) years immediately preceding the date of the Bid, that contains either (a) a contract by contract listing of any written notices of violations of any federal, state or local DBE/MBE/WBE Program and any damages assessed; or (b) a statement that there have been no such written notices of violations or such penalties assessed; and a statement that Program requirements have been met. **[No page limit]**

7. Statement that the Bidder has not been rescinded or debarred from any bidding, contractual, procurement, or other such programs by federal, state or local entities. **[No page limit]**

8. Statement that Bidder is current on payment of Federal and State income tax withholdings and unemployment insurance payments. **[No page limit]**



9. Statement of Bidder's litigation and/or arbitration history over the past five (5) years including final ruling. **[No page limit]**
10. Statement of Bidder's bond history over the past five (5) years including any incidences of failure to perform. **[No page limit]**
11. All contractors will be required to have a payment and performance bond; No Exceptions. Accordingly, provide single project bonding limit and aggregate bonding limit and proof thereof from your company's Surety. **[No page limit]**

Selection of Pre-Qualified Bidders

As noted above, some of the categories will be scored with a point system. Below is an example of how the scoring will be made.

Selection Criteria	Maximum Available Points
Safety Record	20
Key Personnel / Relative Experience	25
DBE Program / Workforce Training	15

The above qualifications and information is due on January 14th, 2014 at 2:00 PM at the below address (NOTE: No email or fax submissions will be accepted):

KC Streetcar Field Office
Attn: Andy Auxier, Senior Project Manager
Re: RFQ-015 Structure Modifications
1828 Walnut St., Suite 500
Kansas City, MO 64108

****Please note the attached document 'Pre-Qualification Checklist' shall be utilized and initialed/signed where required****



Bid Item #	Description	Quantity	Unit of Measure	Unit Price	Total Price
MAIN STREET VIADUCT OVER KCTRR					
M-1	Modify Existing Bridge Expansion Joint (ST104)	458	LF	\$	\$
M-2	Modify Existing Bridge Expansion Joint (ST105)	122	LF	\$	\$
M-3	Modify Longitudinal Joint (ST105)	1,056	LF	\$	\$
M-4	Modify Median Drain (ST106)	18	EA	\$	\$
M-5	Raise Existing Scupper (ST107)	7	EA	\$	\$
M-6	Replace Existing Scupper (ST108)	4	EA	\$	\$
M-7	Replace Existing Inlet (ST108)	1	EA	\$	\$
M-8	Track Drain Connection to Scupper (ST109)	1	LS	\$	\$
M-9	Joint Track and Bridge Drain (ST110)	3	EA	\$	\$
M-10	Preformed Joint Filler at North Abutment	58	LF	\$	\$
M-11	Mudjack Approach Slabs	1	LS	\$	\$
M-12	Remove Existing Barrier	163	LF	\$	\$
M-13	OCS Plate Foundations Type A (ST111)	5	EA	\$	\$
M-14	OCS Plate Foundations Type B (ST111)	-	EA	\$	\$
M-15	OCS Plate Foundations Type C (ST111)	7	EA	\$	\$
M-16	OCS Blister Foundations Type D (ST111)	8	EA	\$	\$
M-17	Cast in Place Barrier (ST114)	904	LF	\$	\$
M-18	CIP Barrier OCS Blister Foundations (ST114)	10	EA	\$	\$
M-19	Turnout Deck Demolition (ST116)	1	LS	\$	\$
M-20	Bridge Conduits (Z101 - Z103A)	1	LS	\$	\$
M-21	Track Flagging/Railroad Permits	1	LS	\$	\$
DELAWARE STREET VIADUCT OVER INTERSTATE 70					
D-1	Mudjack Approach Slabs	1	LS	\$	\$
D-2	Preformed Joint Filler at Abutments	120	LF	\$	\$
D-3	Mounting Blister Foundations (ST118)	9	EA	\$	\$
D-4	Bridge Conduits (Z120, Z121)	1	LS	\$	\$
_____ Name - Print		_____ Signature		_____ Initials	_____ Date
Note: Final quantities to be based on actual work in place or as mutually agreed between Subcontractor, Contractor, Agency and the Owner's Representative					
Inclusions:					
1	Furnish all labor, equipment, materials and supplies for the bid items listed herein and per the Prime Contract documents / Specifications				
2	Payment based on actual quantity/services rendered.				
3	This project is a Buy America project and subcontractor is required to submit material certifications.				
4	This contract will be subject to a 5% retention until project close out.				
5	All mobilizations necessary to complete work in order to maintain project-wide schedule.				
6	Provide and maintain continuous access to businesses, homes, parking lots, sidewalks, temporary pedestrian bridges and driveways as required.				
7	Coordination with the designer/City of Kansas City/third party utilities/Kansas City Streetcar Constructors including their designated QC Manager(s), technicians and inspectors for all required tests and inspections during installation.				
8	Submittals and resubmittals per the contract documents.				
9	Compliance with Kansas City Streetcar Constructors Project QA/QC Plan.				
10	Compliance with storm water pollution control regulations and/or KCMO standard and best management practices.				
11	Contractor's site specific safety plan and supply of MSDS sheets for all products before starting work with specified products.				
12	Coordination with Contractor and other subcontractors to complete work in accordance with the Project Schedule.				
13	Contract insurances including General Liability, Worker Compensation, Automobile, and Railroad (if applicable) per contract requirements.				
14	Payment and Performance Bonds				
15	Street sweeping, general housekeeping of work zones and storage sites.				
16	Temporary water and power, contractors on-site yard facility, employee parking as required per scope of work.				
17	All trucking, offhaul and fees. Includes water trucks as well.				
18	Include any and all applicable taxes.				
19	Coordination with track construction and systems.				
20	Submittal of Best Management Practices (BMP) and residue disposal plan for slurry and debris containment during construction including identified "no discharge zones." All requirements outlined in the plans are inclusive to the unit prices as listed above.				
21	Operations may be suspended by the Engineer during rainfall or freezing temperatures. Provisions may be required, such as heaters, blankets, and tents to maintain the project schedule.				
22	Frame and grate modifications including any touch up painting, welding, and shimming.				
23	All drilling, dowelling, and epoxy as called out in the project drawings, including any additional as a result of damage during demolition.				
24	Item M-9 is for the pipe connection and pressure injected cavities thru the deck and all work under deck. Track drain frame and grate are excluded and will be installed during track construction.				
25	Includes all rebar, bolts, plates, washers, pressure injection of cavities, concrete, and joint filler for foundation and barrier				
26	Epoxy rebar repairs in accordance with MoDOT Standard Specification Section 710				
27	Contractor will be responsible for all railroad coordination, included permits, track flagging, and work plans. Permit fees and track flagger costs will be direct billed against the listed Lump Sum item.				
28	Bridge conduits shall include all required expansion conduits, hangers, struts, all thread, boxes, attachments, etc., and coordinate the mandrelling and tagging with mainline ductbank subcontractor.				
29	Bridge conduits shall include attachments to encased PVC conduits at bridge side wall.				
30	Bridge conduits will include any coring, deck penetrations, nipples, etc required.				
31	Bridge conduits include cable trough on Z101B.				
32	Coring drilling and installation of negative return conduits on sheet Z103A notes 10 & 11				
Exclusions:					
1	Initial project control survey				
2	Quality Control Testing (coordination is required)				
3	Traffic Control (other than track flaggers. Track flaggers are included)				
4	Track Construction and track concrete encasement				
5	Item M-9 track frame and grate.				
6	Z103A conduits and boxes other than those listed in inclusion #32				
7	Hazardous Waste Removal and Disposal				



RFQ015 – Structure Modifications

Scope / Bid Package Narrative and Solicitation
Information

December 18th, 2013



KANSAS CITY STREETCAR
Structure Modifications Pre-Qualification and Bid Package
City of Kansas City - Water
December 20th, 2013

KC Streetcar Project Overview

The above stated project runs generally from the intersection of Pershing Rd on the south end, heading north along Main St. At the intersection of 5th St and Delaware St a loop begins which runs east along 5th St, turning north on Grand Blvd, west on 3rd St and south on Delaware St intersecting again at 5th St and Delaware St. At the intersection of 3rd St and Grand Blvd there is a spur track that runs to the Vehicle Maintenance Facility (VMF). The alignment of the VMF spur runs along Grand Blvd turning east on Oak St and continuing east on the 2nd St corridor approximately 600 ft east of the termination of Oak St.

Throughout the project alignment work will consist of waterline relocations, sewer relocations, sewer rehabilitation, roadway and trackway drainage, earthwork, ductbanks, TPSS buildings and foundations, Overhead Catenary System (OCS) foundations, street lighting, traffic signals, landscaping, track construction, sidewalk restoration, station platforms, overhead catenary systems, traffic signage and striping. The duration of the project is expected to be from 2014 to 2015.

The City of Kansas City has elected to employ a Construction Manager at Risk (CM@Risk) contracting method for the construction of the Project. Herzog/Stacy and Witbeck, Inc. make up the Kansas City Streetcar Constructors, Joint Venture team, and have a long history with the CM@Risk type contracting method. The CM@Risk contracting method allows the Owner and Contractor to work together for the final design phases and deliver the project within a Guaranteed Maximum Price (GMP). During construction, the CM@Risk contractor, their subcontractors, the Owner, designers and stakeholders work together to avoid conflicts, extra costs, time delays and unnecessary impacts to the public. As such, it will be expected of subcontractors on the Project to become part of the overall 'Team'. This means providing proposed solutions to conflicts, value-engineering for cost savings, and construction phasing alternatives.

RFQ015 – Structure Modifications Scope Information

The work consists of:

- Street cleaning and site maintenance
- Expansion Joint Modifications
- Preformed Joint Filler
- Deck Drainage Modifications
- Mudjacking of Approach Slabs
- Concrete Barrier Removal
- CIP Barrier Replacement
- Structural OCS Foundations
- Deck Demolition for Track Turnout
- Bridge Conduits



- Containment Systems
- Track Flagging/Railroad Permits

Attached is a schedule of the materials and the estimated quantity needed for each. All prices quoted for this package should be quoted FOB project.

See attachment A1 for required bid items / schedule of materials.

Referenced Documents

Drawings, specifications, geotechnical report and scheduling/phasing details are attached and incorporated by reference. They are:

1. *Kansas City Streetcar Construction 100% Design Submittal Plans (Volumes 2 & 4)*
 - a. *Dated December 2013*
2. *Kansas City Streetcar Technical Specifications*
 - a. *Dated December 2013*

Scope Narratives

Street cleaning and site maintenance

The subcontractor will be responsible to cleanup all work areas at the end of each work day. This work shall include cleaning of sidewalk, traffic lanes and other surfaces.

Expansion Joint Modifications

Removal of the existing structure expansion joints extrusions and installation of expansion joint sealing system, including the sealing around new rails. The longitudinal expansion joints include the concrete removal around the existing joint, the removal of joint armoring, and the replacement expansion sealing system. Deck concrete grinding will be part of a separate bid package.

Preformed Joint Sealer

The subcontractor is to install preformed joint sealers at Main St. Viaduct north abutment and the Delaware Street Bridge abutments. Work shall include any removal of existing filler as needed to perform the work.

Deck Drainage Modifications

The subcontractor will be responsible for the adjustment/modification of existing scuppers and inlets, including the necessary concrete deck demolition, frame and grate modifications, rebar doweling and placement, concrete placement to adjust inlets and scuppers, pipe, pipe connections and modifications on the under deck. Subcontractor will be required to plumb track drain pipes through deck slab and pressure inject cavities. Track drain frame and grates are excluded. Subcontractor is responsible for coordination and development of work plans for the underdeck access and containment of the work. Work plans are to be submitted and approved before work begins.



Mudjacking of Approach Slabs

Subcontractor is responsible for the mudjacking of existing approach slab. Work includes any coring and containment required. Mudjacking shall be in accordance with Missouri Department of Transportation Engineering Policy Guide Section 771.1 “Mudjacking Bridge Approach.”

Concrete Barrier Removal

Work shall include the safe removal of existing concrete barrier on the structure. Provisions are to include the necessary protection of blunt edges, the proper containment of debris and slurry. Subcontractor will be responsible for the off haul and disposal of the material.

CIP Barrier Replacement

Subcontractor shall cast in place concrete barrier as detailed on the plans. Work includes any demolition of existing deck or sidewalk. Rebar installation including the dowelling and splices of rebar shall be included. Placement of concrete and all concrete embeds, including anchor bolts are the responsibility of the subcontractor.

Structural OCS Foundation

Work includes the installation of all structural foundations including blister foundations, OCS foundations type A, B, and C. Anchor bolts, plates, washers, and conduits shall be included. Subcontractor is responsible for coordination and development of work plans for the underdeck access and containment of the work. Work plans are to be submitted and approved before work begins.

Deck Demolition for Track Turnout

Subcontractor is responsible for the deck demolition for the track turnout on Main St., including the sawcutting, dowelling and rebar splicing, any hand chipping required to protect existing rebar and concrete as required. Work will include laying new rebar as shown. Subcontractor shall develop a support deck to contain the deck demolition, but also support the weight of the track turnout during construction and concrete placement. Subcontractor should plan to have the support deck in place a minimum of 60 days following deck removal to allow for the turnout to be constructed and concrete to cure. Work plans are to be submitted and approved before work begins.

Bridge Conduits

Subcontractor is to install under deck conduits, boxes, and penetrations on the bridge structures, including OCS sweep conduits and connects. Work includes but is not limited to conduits, boxes, hangers, attachment assemblies, core drilling, and cable trough. Subcontractor will be required to coordinate with mainline ductbank subcontractor for connection and mandrelling and tagging of conduits.

Containment Systems

Subcontractor is responsible for coordination and development of work plans for the underdeck access and containment of the work. Plan shall be drafted in accordance with Missouri Department of Transportation Standard Specifications and shall address public access and environmental controls. Work plans are to be submitted and approved before work begins.



Track Flagging/Railroad Permit

Selected subcontractor will be required to apply for track access permits for the adjacent railroad at the Main St. Viaduct. Permit fees and required flagging hours will be included under the lump sum item. Item includes costs for work plans and railroad insurance requirements.

Narratives are provided for bidders' convenience, are general descriptions of the work and not intended to replace or modify scope of work shown in drawings, specifications and other referenced documents.

Buy America Policies

To the extent applicable to the project, the Contractor agrees to comply with 49 U.S.C. §5323 (j), and FTA's Buy America Regulations, "Buy America Requirements," at 49 C.F.R. part 661 and any amendments thereto, which provide that Federal funds may not be obligated unless steel, iron, and manufactured products used in this project are produced in the United States, unless a waiver has been granted.

Schedule

The bulk of the Main Street Viaduct structural modifications will be constructed in the early calendar year of 2014, beginning in February 2014. The track turnout deck demolition and south end expansion joint and scuppers will take place in late 2014 or early 2015 in conjunction with the delivery of the track turnout.

The Delaware Street Viaduct Modifications will take place following the bulk of the Main Street Viaduct work.

All work schedules shall take into account the following:

- Holiday & Special Event Moratorium's
- Property Procurements
- Specific Project Sequencing

It will be important for bidders to be able to be flexible in regards to schedule and sequence of work. It should be reiterated that subcontractors should have the equipment, skilled labor, supervision and vendor/supplier resources to maintain project schedule.

DBE Goal:

The KC Streetcar Project has an overall DBE goal of 24% for the project, as such the selected contractor will be required to meet or exceed the 24% DBE goal. All good faith efforts are to be documented per the contract specifications.



Selection of Bidder

The contractor will be selected in a two phase process as outlined below:

- **Phase One – Pre-Qualification of Bidders**
 - This process will consist of pre-qualify bidders whom will be scored and selected by a panel consisting of the KCSC project management and KCMO project management. The reasoning of the pre-qualification is to ensure that the successful subcontractor can adequately understand, manage, staff, bond and perform the overall structural modifications of the project is selected. Due to the highly complex design, the nature of work in a dense urban environment, the safety elements to the work, multiple facets of work and scheduling with other contractors and private parties, and to maintain the overall project schedule it is necessary to select a pre-qualified list of subcontractors.
- **Phase Two – Bid Selection**
 - This process will consist of the pre-qualified bidders providing pricing for the overall scope of work on the project as it is related to this specific bid package.

Schedule of Bidder Selections

- Phase One
 - Pre-Qualification Packages will be due on 1/14/2013 at 2:00 PM
 - Notification to pre-qualified bidders will be completed by 1/15/2013 unless otherwise noted
- Phase Two – Bid Selection
 - Bid Packages will be due on 1/22/2014 at 2:00 PM
 - Last date for RFI's will be 1/17/2014 at 2:00 PM

Pre-Qualification Packages and Bid Packages shall be submitted to:

Kansas City Streetcar Constructors

Attn: Andy Auxier, Senior Project Manager

Re: Structural Modification Bid Package

1828 Walnut St.

Suite 500

Kansas City, MO 64108

All questions must be on the attached RFI form (Attachment "K") and sent via fax or email to:

Kansas City Streetcar Constructors

Fax: 816-448-2111

dcctrl@kcscjv.com

**SUBCONTRACT
AGREEMENT**

Job No. 49574
Subcontract No. ???

THIS AGREEMENT, made this _____ day of _____ 2013, by and between _____, whose address is _____ and Phone: _____ and Fax: _____, hereinafter called the "Subcontractor", and **KC Streetcar Constructors**, whose address and telephone number is 1828 Walnut Street, Suite 500, Kansas City, MO 64108- Phone (816) - 448-2110 and Fax (816)-448-2111, hereinafter called "Contractor."
WITNESSETH:

For good and valuable consideration, Contractor and Subcontractor agree as follows:

Section 1. Contract Documents. The Subcontractor agrees to furnish all supervision, labor, tools, equipment, materials and supplies necessary to perform, and to perform, all work set forth in Section 2 hereof in connection with the construction of **Kansas City Downtown Streetcar** for **City of Kansas City, MO** the Owner, at **1st Floor, 102 W, City Hall 414 East 12th Street Kansas City, MO 64106**, in accordance with the terms and provisions of the Contract between the Owner and the Contractor dated 10-28-13, including all the General and Special Conditions, Drawings, Specifications, Schedules and other documents forming or by reference made a part of the Contract between the Contractor and the Owner, all of which shall be considered part of this Subcontract by reference thereto, and the Subcontractor agrees to be bound to the Contractor and the Owner by the terms and provisions thereof.

Section 2. Scope of Work. The Subcontractor agrees to perform the following described work:

ITEM#	DESCRIPTION/WORK	EST. QTY	UNIT	UNIT PRICE	AMOUNT
-------	------------------	----------	------	------------	--------

All in conformance with the contract specifications and drawings as approved by the Owner

No exclusion from the Scope of Subcontractor's Work shall be recognized unless it is expressly and clearly set forth in detail in Subcontractor's description of work as stated in section 2 above.

When the Subcontractor does not install all material furnished under this Subcontract, such material that is not installed is to be delivered F.O.B. Jobsite or as required by the Contract Documents.

Section 3. Payment. (a) The Contractor agrees to pay the Subcontractor for the performance of this Subcontract, as specified herein, the sum of _____ Dollars (\$_____) subject to additions and deductions for changes agreed upon or determined, as hereinafter provided. Partial payments will be made to the Subcontractor each month equal to 95 percent of the value, computed on the basis of the prices set forth above, of the quantity, as estimated by the Owner, Architect or Engineer, of the work performed hereunder, less the aggregate of previous payments, but such partial payments shall not become due to the Subcontractor until 10 days after the Contractor receives payment for such work from the Owner. If the Contractor receives payment from the Owner for material delivered to the site but not yet incorporated into the work, the Subcontractor shall receive its proportionate share of such material allowance, less retainage. No partial payment to the Subcontractor shall operate as approval or acceptance of work done or materials furnished hereunder. Upon complete performance of this Subcontract by the Subcontractor and final approval and acceptance of Subcontractor's work and materials by the Owner, and after receipt of lien waivers, the Contractor will make final payment to the Subcontractor of the balance due under this Subcontract within thirty days after full payment for such work and materials has been received by the Contractor from the Owner. Payment by the Owner to the Contractor is a condition precedent to payment by the Contractor to the Subcontractor.

(b) If at any time prior to final payment hereunder, the Owner reduces the amount of retainage withheld from the Contractor, the Contractor may, in its sole discretion, reduce accordingly the retained percentage withheld from the Subcontractor or make payments to Subcontractor before such payments are due without waiving any provision of Section 3 herein.

(c) The Contractor may deduct from any amounts due or to become due to the Subcontractor any sum or sums owed by the Subcontractor to the Contractor or Contractor may, at its option, make direct payments to the Subcontractor's suppliers, employees, or subcontractors. In the event of any breach by the Subcontractor of any provision or obligation of this Subcontract or in the event of the assertion by other parties of any claim or lien against the Contractor or the premises arising out of the Subcontractor's performance of this Subcontract, the Contractor in its sole discretion shall have the right to retain out of any payments due or to become due to the Subcontractor an amount it deems sufficient to completely protect the Contractor from any and all loss, damage or expense therefrom, including attorney fees and other legal expenses, if any, until the situation has been satisfactorily remedied or adjusted by the Subcontractor.

(d) The acceptance by the Subcontractor of the final payment under this subcontract shall be and shall operate as a complete and unconditional release to the Contractor of any and all existing or future claims or demands by the Subcontractor, or its surety, against the Contractor known or Unknown, hereunder or in connection herewith, whatever they may be or howsoever they may arise as well as for every act and neglect of the Contractor and any person for whom the Contractor shall or may be deemed responsible.

(e) Subcontractor shall forward and Contractor or Owner shall review and approve if applicable the Project Workforce Monthly Report, the Company-Wide Workforce Monthly Report and Certified Payroll Report(s). The before mentioned forms/reports being received and approved as deemed necessary by Contractor is a condition of payment from Contractor to Subcontractor.

Section 4. Taxes and Contributions. Taxes are included in the price to be paid Subcontractor under this Subcontract, and Subcontractor assume and accepts exclusive liability for , and agrees to pay (a) all taxes and contributions required to be withheld from, or in respect of, wages and salaries, under any law or collective bargaining agreement now existing or hereafter imposed, including interest and penalties, (b) all taxes, contributions, interest and penalties under any federal, state municipal or other governmental or private old age benefit, welfare benefit, social security, pension, annuity, or unemployment compensation or insurance law plan or program now existing or hereafter imposed, and (c) all taxes measured by receipts in connection with the work under this Subcontract and all sales, use income, occupation, or excise taxes, including interest and penalties, referable to the Subcontract or anything to be done or furnished hereunder and all permits, fees and licenses relative to the work covered by the Subcontract. If Contractor pays any such taxes, contributions, interest or penalties, Subcontractor on demand shall reimburse Contractor therefore or Contractor may deduct the same from sums otherwise due Subcontractor.

Section 5. Changes. The Contractor may at any time by written order and without notice to the Subcontractor's sureties, make changes in, additions to or deletions from, the work to be performed, or materials to be furnished under this Subcontract, and the Subcontractor shall promptly proceed with the performance of this Subcontract as so changed. Any increase or decrease in the Subcontract price resulting from such changes shall be agreed upon in writing by the parties hereto. Any claim or adjustment of the Subcontract price under this Section must be made in writing within ten days from the day such changes are ordered. The Subcontract price shall be equitably adjusted on account of any such changes, subject to any applicable provisions of the Contract between the Contractor and the Owner. The Contractor, in the event of additional work, shall not be liable for a greater sum than the Contractor obtains from the Owner for such additional work, less reasonable overhead and profit to the Contractor. Subcontractor will pay to Contractor the professional and counsel fees, costs and expenses incurred by the Contractor in the collection of any such sums of money. The recovery by Subcontractor for such work shall be conditional upon a prior recovery by the Contractor from the Owner.

Section 6. Prosecution of Work. (a) The Subcontractor shall furnish all labor, supervision, tools, equipment, materials and supplies necessary for the performance of this Subcontract in a proper, efficient and workmanlike manner. The Subcontractor shall prosecute the work undertaken in a prompt and diligent manner whenever such work, or any part of it, becomes available or at such other time or times as the Contractor may direct, and so as to promote the general progress of the entire project, and shall not, by delay or otherwise, interfere with or hinder the work of the Contractor or any other subcontractor. Time is of the essence. Any materials that are to be furnished by the Subcontractor hereunder shall be furnished in sufficient time to enable the Subcontractor to perform and complete its work within the time or times specified. The Subcontractor

agrees to reimburse the Contractor for any and all liquidated or actual damages that may be assessed against and collected from the Contractor which are attributable to or caused by the Subcontractor's failure to furnish the materials and/or perform the work required by this Subcontract within the time fixed or in the manner provided for herein, and, in addition thereto, agrees to pay to the Contractor such other or additional damages as the Contractor may sustain by reason of such delay by the Subcontractor. Such additional damages shall include reasonable attorney fees, expenses of litigation, and collection of such money. The payment of such damages shall not release the Subcontractor from its obligation to otherwise fully perform this Subcontract. Upon written request by the Contractor, the Subcontractor shall furnish to the Contractor such evidence as the Contractor may require relating to the subcontractor's ability to fully perform this Subcontract in the manner and within the time specified.

(b) In the event the Subcontractor fails to comply, or becomes disabled from complying with the provisions herein as to character or time of performance, and the failure is not corrected within five days after written request by the Contractor to the Subcontractor, the Contractor, by subcontractor or otherwise, may without prejudice to any other right or remedy, take over and complete the performance of this Subcontract at the expense of the Subcontractor, or, without taking over the work, may furnish the necessary materials and/or employ the personnel necessary to remedy the situation at the expense of the Subcontractor. If the Contractor takes over the work pursuant to this paragraph it is specifically agreed that the Contractor may take possession of the premises and of all materials, tools and equipment of the Subcontractor for the purpose of completing the work covered by this Subcontract.

(c) It is agreed that the Subcontractor shall be considered as disabled from so complying with this Subcontract whenever the Subcontractor commits any act of Bankruptcy, or a voluntary or involuntary petition in Bankruptcy is filed against or on behalf of the Subcontractor, or the appointment of a receiver is filed against the Subcontractor.

Section 7. Delays. To the maximum extent permitted by law (a) In the event the Subcontractor's performance of this Subcontract is delayed or interfered with by act of the Owner, Contractor or other subcontractors, it may request an extension of the time for the performance of same, as hereinafter provided, but shall not be entitled to any increase in the Subcontract price or to damages or additional compensation as a consequence of such delays or interference, except to the extent that the Contract entitles the Contractor to compensation for such delays and then only to the extent of any amounts that the Contractor may on behalf of the Subcontractor recover from the Owner for such delays.

(b) No allowance for an extension of time, for any cause whatsoever, shall be claimed by, or made to, the Subcontractor unless the Subcontractor shall have made written request upon the Contractor for such extension within forty-eight hours after the cause of such extension occurred, or, if the Contract between the Contractor and Owner provides for a shorter period, within sufficient time to permit the Contractor to give notice to the Owner within the time allowed by the Contract for such notice.

(c) No allowance of an extension of time shall, in any event, be made to the Subcontractor for delay by the Subcontractor when the Subcontractor by the exercise of reasonable diligence and judgment could have anticipated and avoided the delay.

Section 8. Default. In addition to any other conduct or event designated in this Subcontract as a default, if (a) Subcontractor shall fail to furnish materials of the quantity or to do work in the manner required by the Contractor and the Contract Documents, or (b) Subcontractor shall fail to provide supervisory personnel or workers in numbers and experience or equipment in kind and capacity suitable to the Owner, Engineer or Contractor, or (c) Subcontractor shall fail to diligently prosecute the work required to be done under the Subcontract in the particular order or sequence requested by Contractor or to keep pace with the progress schedule formulated from time to time by Contractor, or (d) Subcontractor shall abandon said work or any part thereof as determined by Contractor, or (e) if Subcontractor should file a petition in bankruptcy or for any arrangement of creditor shall be filed by or against Subcontractor or Subcontractor shall become insolvent or make an assignment for the benefit of creditors or commit any act of bankruptcy, or (f) Subcontractor shall fail to promptly pay for all labor, material and everything else used in connection with the Subcontract, or fail to promptly provide evidence of such payment upon the written request of Contractor or (g) Subcontractor shall fail to maintain insurance or provide proof of insurance as required by the Subcontract, or (h) Subcontractor shall fail in any manner to perform the whole or any part of any term, provision, covenant or agreement contained or assumed herein; then and upon the occurrence of any such event (and Contractor's finding and judgment with respect thereto shall be final and bind the Subcontractor absolutely), in addition to any other right herein, Contractor shall have the right to:

- (a) Withhold any further payment hereunder from Subcontractor until all work to be performed by Subcontractor shall be wholly finished,
- (b) Provide or have others provide such materials, supplies, equipment and labor in addition to any supplied by Subcontractor, as may be necessary to complete Subcontractor's work and pay for the same and deduct the amount thereof from any money which is then or would thereafter otherwise be due Subcontractor,
- (c) Pay for all of the same and deduct the amount so paid from any money which is then or would thereafter otherwise be due Subcontractor,
- (d) Bar Subcontractor from the Project (with or without terminating the Subcontract),
- (e) Enter upon the premises and take possession for use and consumption in completing the work of all the materials, supplies, tools, equipment, appliances, facilities, records and shop drawings of the Subcontractor thereon and complete the work, or have the same completed by others, or any combination of such methods, and/or
- (f) Terminate the Subcontractor's rights under this Subcontract.

On the happening of any such event, Subcontractor shall not be entitled to receive any further payment hereunder, and Contractor shall have no liability to Subcontractor therefore, until final payment for the entire Project has been received by Contractor from Owner, and Subcontractor shall only be entitled to, and Contractor shall only be liable for, the amount, if any, by which the unpaid portion of this Subcontract shall exceed the cost, expense and damage incurred by Contractor (including attorneys' fees and related costs) because of Subcontractor's default and/or delays and in completing the work covered hereby and performing the other obligations of Subcontractor hereunder. If such damages and amounts expended or incurred by Contractor exceed the balance of the Subcontract price, Subcontractor or its sureties or both shall pay Contractor such excess promptly after Contractor's demand therefor, and upon their failure to do so, in addition to Contractor's right on or under any bonds of the Subcontractor, Contractor shall have the right, pursuant to the lien provided for herein, to sell all materials, tools, appliances, equipment and facilities of Subcontractor not previously used or consumed in the performance of said work and to apply the proceeds of such sale(s) to the obligation of Subcontractor and its sureties who nevertheless shall remain liable for any deficiency. Contractor shall not be required to exercise any such lien rights as a condition to receiving full payment from Subcontractor and its sureties.

Section 9 . Termination for Convenience of the Contractor. The performance of work under this Subcontract may be terminated by the Contractor in accordance with this Section in whole, or from time to time in part, whenever the Contractor shall determine that such termination is in the best interest of the Contractor. Any such termination shall be effected by delivery to the Subcontractor of a Notice to Termination specifying the extent to which performance of work under the Subcontract is terminated, and the date upon which termination becomes effective. After receipt of a Notice of Termination, and except as otherwise directed by the Contractor, the Subcontractor shall stop work under the Subcontract on the date and to the extent specified in the Notice of Termination, and using its best effort, close-out Subcontractor's performance in a prudent and economical manner.

Subcontractor shall assign to the Contractor in the manner, at the times, and to the extent directed by Contractor, all of the rights, titles, and interests of the Subcontractor under the orders and subcontracts so terminated, in which case the Contractor shall have the right, in its discretion to settle or pay any claims arising out of the termination of such orders and subcontracts.

Subcontractor must settle all outstanding liabilities and all claims arising out of such termination of orders and subcontracts, with the written approval or ratification of the Contractor, which must not be unreasonably withheld.

Section 10 . Labor. The Subcontractor, in connection with all work covered by this Subcontract, shall comply with and be bound by any labor agreements executed by the Contractor or on Contractor's behalf to the extent that the provisions of such agreements apply to subcontractors. Failure at any time to comply with any of the provisions of such agreements will, at the option of the Contractor, be cause for immediate termination of this Subcontract for default and the Contractor shall have all the rights contained in Section 8 with regard to such termination. If, by reason of strikes, picketing or disputes of any nature between the Subcontractor and any individual group or organization, the Subcontractor should be persistently, repeatedly, or for a period of five (5) consecutive days, unable to supply enough properly skilled employees or proper materials to execute the work of this Subcontract, then the Contractor may terminate the Subcontract for default and proceed in accordance with Section 8 thereof.

Section 11 . Approvals. All submittals of the Subcontractor shall be submitted for the approval of the Owner, Architect, or Engineer through the Contractor.

Section 12 . Communications and Correspondence. All communications and correspondence, written or oral, must be directed through the Contractor, Subcontractor must keep the Contractor fully informed of any communication and correspondence received from the Owner, Architect or Engineer and any other third party.

Section 13. Indemnification. (a) To the fullest extent permitted by law, it is expressly agreed and understood that the Subcontractor shall indemnify, defend, and hold harmless Contractor (including its owners, affiliates and subsidiaries), its officers, directors, agents, shareholders ,employees, successors, sureties, the Project Owner and any other parties which Contractor is required under the Prime Contract or by law to defend, indemnify and/or hold harmless, from and against any and all claims, liability, actions, causes of actions, complaints, laws, expenses and demands whatsoever, in law and equity, including without limitation for bodily injury, personal injury, sickness, disease, death or property damage (including but not limited to the project itself), arising out of, or alleged to arise out of, or as a result of, or alleged as a result of, or to arise out of the performance of the Subcontractor's work under this Subcontract, regardless of negligence. Subcontractor, at Subcontractor's sole expense, shall promptly handle all such claims, defend all lawsuits filed against Contractor on account thereof, pay all judgments rendered against Contractor in such lawsuits (including any prejudgment interest assessed against any Indemnitee hereunder), and reimburse Contractor in cash upon demand for all reasonable expenses incurred by Contractor on account thereof including, but not limited to, attorney fees, expert witness fees and court costs. It is expressly agreed and understood by Subcontractor that Subcontractor shall indemnify Contractor and hold it harmless from the above referenced claims regardless of whether such claim is caused or alleged to be caused in part by any joint or concurrent negligent act (either active or passive) or omission by a party indemnified hereunder.

(b) Subcontractor agrees to indemnify and hold harmless Contractor from any and all claims or suits for infringement of patents, or violations of patent rights by Subcontractor, and further agrees to pay all losses and expenses incurred by Contractor by reason of any such claims or suits including, but not limited to, attorney fees and court costs.

(c) The Subcontractor, its agents, employees, subcontractors or suppliers shall not use the Contractor's equipment without the express written permission of the Contractor's designated representative. If the Subcontract or any of its agents, employees, suppliers or lower tier subcontractors utilize any machinery, equipment, tools, scaffolding, hoists, lifts or similar items owned, leased, or under the control of Contractor, the Subcontractor shall be liable to the Contractor as provided in this Subcontract for any loss or damage (including personal injury or death) which may arise from such use, except where such loss or damage shall be found to have been due solely to the negligence of the Contractor's employees operating such equipment.

(d) Subcontractor agrees to pay for all materials furnished and work and labor performed under this Subcontract, and to satisfy the Contractor thereupon whenever demand is made, and to indemnify the Contractor and the Owner against and save them and the premises harmless from any and all claims, suits or liens by others than the Subcontractor.

(e) Subcontractor agrees to obtain and pay for all permits, licenses and official inspections required by its work and to comply with all laws, ordinances and regulations bearing on its work and the conduct thereof; and in the event that Contractor, or any other entity designated by contractor, obtains such permits, licenses and official inspections, Subcontractor agrees to fully indemnify Contractor for all costs, fees and expenses therefor.

(f) The Subcontractor warrants and guarantees the work and materials covered by this Subcontract and agrees to make good, at its own expense, any defect in materials or workmanship which may occur or develop prior to the Contractor's release from responsibility to the Owner therefor.

(g) The Subcontractor assumes toward the Contractor all the obligations and responsibilities that the Contractor assumes toward the Owner, as set forth in the Contract, General and Special Conditions, Drawings, Specifications, Schedules, and other documents hereinabove referred to insofar as applicable, generally or specifically, to the materials to be furnished and the work to be performed under this Subcontract. The Subcontractor shall indemnify the Contractor and the Owner against, and save them harmless from, any and all loss, damage, costs, expenses and attorney fees suffered or incurred on account of any breach of the

aforsaid obligations and covenants, and any other provision or covenant of this Subcontract.

Section 14. Insurance. (a) Prior to the commencement of the Subcontract work, the Subcontractor shall procure and maintain in force for the duration of the term of the Subcontract the following insurance coverages and minimum limits with insurance companies acceptable to the Contractor:

Worker's Compensation - Shall provide coverage for statutory benefits and Employer's Liability Coverage of not less than \$500,000 per occurrence. The policy shall contain an All States endorsement. The policy shall be endorsed to provide a waiver of subrogation in favor of the Contractor. If the work under the Subcontract is in proximity to a navigatable waterway, then the policy shall be endorsed to include coverage for the United States Longshoremen and Harbor Worker's Act. The policy shall be endorsed to provide 30 days written notice to Contractor of cancellation and/or material change in coverages.

Commercial General Liability - Shall be written on an occurrence basis with limits not less than \$1,000,000. The policy shall include coverage for Premises/Operations (including keeping in force for two years post completion), Independent Contractors, Contractual Liability (sufficient to cover the liability assumed by the Subcontractor under paragraph (a) of this Section), Property Damage arising out of the "XCU" hazards, Completed Operations/Products, Broad Form Property Damage, and Personal Injury. If the policy contains a general aggregate limitation, then the policy shall be endorsed to provide a \$1,000,000 specific aggregate for the work under this Subcontract. The policy shall name the Contractor as an Additional Insured (including completed operations) and be endorsed to state that the insurance provided to Contractor shall be primary insurance with respect to Contractor, and any other insurance policy that the Contractor may have in effect shall be deemed excess and not contributory. Such additional insured endorsement shall be CG-20 10 (11 85) or CG-20 10 (10 01) in combination with CG 20 37 or their equivalent. The policy shall be endorsed to provide 30 days written notice to Contractor of cancellation and/or material change in coverages. Any exclusion pertaining to work within fifty feet (50') of any railroad track shall be deleted.

Comprehensive Automobile Liability - The policy shall contain limits of not less than \$1,000,000 Combined Single Limit and include coverage for all Owned, Hired, and Non-owned vehicles. The policy shall name the Contractor as an Additional Insured and be endorsed to state that the insurance provided to Contractor shall be primary insurance with respect to Contractor, and any other insurance policy that the Contractor may have in effect shall be deemed excess and not contributory. Any exclusion pertaining to work within fifty feet (50') of any railroad track shall be deleted.

Marine Insurance - If the Subcontractor will use marine vessels in the prosecution of the work, the Subcontractor shall purchase Protection and Indemnity insurance with limits of not less than \$500,000. The policy shall name the Contractor as an Additional Insured and be endorsed to state that the insurance provided to Contractor shall be primary insurance with respect to Contractor, and any other insurance policy that the Contractor may have in effect shall be deemed excess and not contributory. The Subcontractor's Worker's Compensation Insurance shall be endorsed to provide coverage for Outer Continental Shelf Operations and liability for disease, wages, maintenance and cure. If the Subcontractor purchases Hull Insurance, such Hull Insurance shall be endorsed to provide a waiver of subrogation in favor of Contractor.

Excess/Umbrella Liability - The policy(ies) shall be written with limits of not less than \$5,000,000 Combined Single Limit and shall be endorsed to be following form of the Comprehensive General Liability, Comprehensive Automobile Liability, Protection and Indemnity Insurance, and Employer's Liability coverages.

(b) It is understood and agreed that the insurance coverages and limits required shall not limit the extent of the Subcontractor's responsibilities and liabilities specified with the in Contract Documents or by law

(c) The policies obtained and maintained to provide the specific insurance must provide that the required coverages and limits will not be altered, canceled, or allow to expire without at least 30 days prior written notice to Contractor

(d) Any deductible amounts which may occur as part of any policy shall be borne by the Subcontractor.

(e) It is understood and agreed that authorization is hereby granted to Contractor to withhold payments to the Subcontractor until a properly executed Certificate of Insurance providing insurance required herein, accompanied by a signed subcontract are received by Contractor

(f) Prior to commencing the work, Subcontractor shall cause to be completed by an authorized representative Exhibit A, **Certificate of Insurance**, as evidence of Subcontractor's compliance to paragraph (b) of this Section. In the event that the Subcontractor fails to obtain and keep in full force and effect any of the insurance requirements under this Subcontract, the Contractor may purchase such coverage and use any funds payable to the Subcontractor to satisfy any premium requirements.

Section 15. Bonds. The Subcontractor shall furnish Performance and Payment Bonds in an amount equal to the full Subcontract price at least fifteen (15) days before commencing work on the Project. The bonds shall be in a form satisfactory to the Contractor, and shall guarantee respectively the faithful performance of the Subcontract, and each and all of its stipulations and agreements, and the payment of all persons furnishing labor, services, equipment or materials used or purchased for use in the work covered by the Subcontract. If Maintenance Bonds are required, the Subcontractor shall furnish such bonds for its portion of the work. Bonds shall be on forms and with a surety satisfactory to the Contractor. Premiums for the bonds shall be paid by the Subcontractor and are included in the Subcontract sum or as stated otherwise herein.

Should any contract modification(s) result in an increase in the amount of this Subcontract, Subcontractor and Surety shall increase the amounts of such bonds accordingly, and it will be the responsibility of Subcontractor to include in its proposal the cost of additional bond premiums to cover the additional amount. If the Subcontractor fails to furnish the aforesaid bonds before commencing work or fails increase the amount of such bonds if required under this subsection, or if the surety is in receivership or otherwise unable to perform its obligations and a replacement surety satisfactory to Contractor is not promptly provided, Contractor may declare Subcontractor to be in default hereunder and to have breached this Subcontract. Should Subcontractor be in default under this provision, all rights and remedies available under Section 7 "Default" are available to Contractor.

Section 16 . Third Party. The parties hereto do not intend by any provisions hereof to create any third-party beneficiaries, nor to confer any benefit upon or enforceable right hereunder or otherwise upon anyone other than the parties hereto.

Any decision concerning the work, the intendment or application of the Contract or claims for payment or compensation thereunder for work done or omitted hereunder which are binding upon the Contractor shall bind the Subcontractor absolutely, whether such decision be made by the Owner, the Architect, the Engineer or any officer, agency or tribunal empowered to render the same by the Contract or any procedure referred to therein or contemplated thereby.

The Contractor may dispute, appeal from and in every manner resist and litigate any and every such decision without being deemed thereby to have admitted any obligation or liability to the Subcontractor, and if the decision shall go against the Contractor then the Subcontractor shall be concluded thereby, and nothing previously said, done, contended or stipulated by the Contractor shall be offered or received in evidence in any proceeding of the Subcontractor against the Contractor.

In any and all events, the Subcontractor shall bear a just part of all costs and expenses incurred by the Contractor in any proceeding, appeal or litigation involving a claim which if allowed would result in a payment(s) to the Subcontractor in the proportion that the amount claimed for the benefit of the Subcontractor shall bear to the whole amount sought in the same proceeding, appeal or litigation.

The Contractor shall not be obligated to assert or continue the prosecution of any claim for the benefit of a Subcontractor, nor to maintain or continue any proceeding, appeal or litigation thereon, and may refrain from asserting or abandon the same at any stage, in the discretion of the Contractor, unless the Subcontractor demands, in writing, presentation or continuation thereof and pays in advance to counsel, designated by the Contractor, a retainer to apply on the final fee, such counsel's estimate of the costs and expenses of the proceeding, appeal or litigation so demanded, and cooperates with such counsel fully in the compilation and presentation of supporting data and evidence. In any and all events the prosecution of any such claim shall be at the risk of the Subcontractor and Contractor shall have no responsibility or liability for or in relation to the outcome thereof.

Section 17 . Possession Prior to Completion. Whenever it may be necessary for the Contractor to do so, the Contractor shall be permitted to occupy and/or use any portion of the project which has been either

partially or fully completed by the Subcontractor before the final inspection and acceptance thereof by the Owner, but such use and/or occupation shall not relieve the Subcontractor of its guarantee of said work and materials or of its obligation to make good at its own expense any defect in materials and/or workmanship which may occur or develop prior to the Contractor's release from responsibility to the Owner. However, the Subcontractor shall not be responsible for the maintenance of such portion of the work as may be used and/or occupied by the Contractor, nor for any damage thereto that is due to or caused by the negligence of the Contractor during such period of use or occupancy.

Section 18 . Other Contracts. It is understood and agreed that the work provided for in this Subcontract constitutes only a part of the work being performed for the Owner by the Contractor and other subcontractors. The Subcontractor, therefore, agrees to perform the work called for in this Subcontract in such a manner that it will not injure, damage or delay any other work performed by the Contractor or any other subcontractor, and further agrees to pay the Contractor for any damage or delay that may be caused to such other work by the Subcontractor or by its agents or employees.

Section 19 . Independent Contractor. The Subcontractor specifically agrees that it is, or prior to the start of work hereunder will become, an independent contractor of an employing unit subject as an employer to all applicable Unemployment Compensation statutes so as to relieve the Contractor of any responsibility or liability for treating Subcontractor's employees as employees of the Contractor for the purpose of keeping records, making reports and payment of Unemployment Compensation taxes, or other taxes or contributions; and the Subcontractor agrees to indemnify and hold the Contractor harmless and reimburse it for any expense, including reasonable attorney fees and expenses of litigation or liability incurred under said statutes in connection with employees of the Subcontractor, including a sum equal to benefits paid to those who were Subcontractor's employees, where such benefit payments are charges to the Contractor under any Merit Plan or its individual Reserve Account pursuant to any state unemployment compensation statute.

Section 20 . Compliance with Law. (a) The Subcontractor further agrees as regards (1) the production, purchase and sale, furnishing and delivering, pricing, and use or consumption of materials, supplies and equipment; (2) the hire, tenure or conditions of employment of employees and their hours of work and rates of and the payment of their wages, and (3) the keeping of records, making of reports, and the payment, collection, and/or deduction of Federal, State and local taxes and contributions, that it will keep and have available all necessary records and make all payments, reports, collections and deductions, and otherwise do any and all things so as to fully comply with all Federal, State and local laws, ordinances and regulations in regard to any and all said matters insofar as they affect or involve the Subcontractor's performance of this Subcontract, including but not limited to, the Occupational Safety and Health Act of 1970, Mine Safety and Health Act, Environmental Protection Agency laws and regulations, the Immigration Reform and Control Act of 1986, Executive Order 11246 dated September 24, 1965 (30FR12319) (Equal Opportunity Clause) and the Contract Work Hours and Safety Standards Act. Subcontractor agrees to immediately remedy any condition causing a violation of any law, code, ordinance, regulation, etc., and shall defend and hold Contractor and Owner harmless from any penalty, fine or liability in connection therewith.

(b) Subcontractor hereby affirmatively states that it does not employ, hire for employment, or continue to employ any person who is unlawfully present and/or unauthorized to work in the United States in connection with the contracted services with Contractor. Subcontractor agrees to promptly (within 10 business days) provide to Contractor a sworn affidavit under penalty of perjury attesting to the fact that Subcontractor's employees are lawfully present in the United States. Failure to promptly provide the requested affidavit (within 10 days) will constitute a breach of this subcontract.

(c) Should Contractor and/or any of its owners or employees or subsidiaries incur any liability, penalty, cost or expense, including legal expenses, in connection with Subcontractor's failure or alleged failure to comply with any United States federal or state immigration laws, Subcontractor agrees to indemnify and hold harmless Contractor (and/or any of its owners or employees or subsidiaries) for any such liability, penalty, cost or expense incurred, including reasonable attorney fees.

(d) The Subcontractor shall be responsible for the layout and survey required for its work and for the safety and traffic control of its work and shall furnish and maintain all lights, guards, signs, barricades, flagmen, temporary passages and other necessary protection and precautions for that purpose.

(e) Subcontractor agrees not to discriminate against any employee or applicant for employment because of race, religion, sex, color, national origin, or handicap. The aforesaid provision shall include, but not be limited to the following: employment, upgrading, demotion or transfer; recruitment or recruitment

advertising; layoff or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship.

Section 21. Safety-Responsibility. Subcontractor assumes exclusive responsibility for protection of its personnel, materials, equipment, facilities and work. If Contractor shall maintain first aid service at the site of said Project, Subcontractor shall bear its fair share of the cost thereof. Subcontractor shall provide sufficient, safe and proper facilities for inspection by Contractor and the Engineer of the work and materials of the Subcontractor, whether in the field, at shops, or at any place where such materials may be in preparation, manufacture, storage or installation.

Subcontractor agrees to abide by all safety rules, practices and programs as established by Contractor, the Occupational Safety and Health Act of 1970, as amended, and all other applicable safety rules and regulations whether state, federal or local (collectively referred to as the "Act") and shall be exclusively liable for the safety of its employees and for any violation of the Act either as to the work of Subcontractor or its portion of any jobsite or affecting the agents, employees, subcontractors or representatives of Subcontractor, Contractor or others in its work area.

Subcontractor acknowledges and agrees that its work area on this Project and all places where its employees, agents, materials, supplies, equipment and facilities are at any time or shall be at any time are and shall be under its exclusive control and Subcontractor is and shall be solely responsible for the detection and abatement of any conditions not in compliance with the Act, and Contractor is and shall not be responsible therefore. Notwithstanding the above, if, in the sole opinion of Contractor's representative, the Subcontractor is conducting or performing any of its work in an unsafe manner, the Contractor may direct that the work be discontinued until the unsafe practices are corrected. Should the Subcontractor continue to prosecute the work in an unsafe manner, the Contractor may terminate this Subcontract for default and the Contractor shall have all the rights contained in Section 8 with regard to default and/or termination.

Section 22. Protection of Work. Except as provided in Sections 13 and 14 above, the Subcontractor specifically agrees that it is responsible for the protection of its work until final completion and acceptance thereof by the Owner and that it will make good or replace, at no expense to the Contractor or Owner, any damage to its work which occurs prior to said final acceptance.

Section 23. Architect-Engineer. The words "Architect or Engineer" as used herein refer to the person appointed by the Owner to supervise the work of the Contractor on behalf of the Owner.

Section 24. Assignment. The Contractor expressly reserves the right to reject, in whole or in part, any assignment, subletting or subcontracting of any portion of this Subcontract, including materialmen or suppliers. Subcontractor agrees to advise Contractor promptly when, and if, any such assignment, subletting or subcontracting has occurred, and to provide a copy of the agreement to Contractor.

Contractor, in its sole discretion, may also consent to the assignment of all or a portion of the work remaining under this Subcontract to another that purchases the business of the Subcontractor and/or its assets. Any such consent to assignment by the Contractor must be in writing, and may include a requirement that the purchaser and/or assignee also assume any remaining rights and responsibilities of the Subcontractor under this Subcontract, including all remaining liabilities.

Subcontractor shall ensure that all benefits of its subcontracts, purchase orders and other agreements are assignable to the Contractor, at the option of the Contractor. The terms and provisions of this Subcontract shall be incorporated by reference into any and all agreements between Subcontractor and its subcontractors, materialmen or suppliers.

Section 25. Notice to Proceed. Receipt of the executed Subcontract does not constitute Notice to Proceed. Notice to proceed will be issued in writing at the field level when the proper insurance and bond documents have been received and approved. Notice to proceed will be issued to the Subcontractor ten (10) days prior to starting the work herein. The Subcontractor will proceed with its work within the given time and pursue its work as set forth in the articles of this Subcontract, the Owner's Contract and as otherwise directed by the Contractor. Work per this Subcontract may require progression on individual or successive sets of days as necessitated by project scheduling and completion.

Section 26. Examination of the Project Plans, Specifications, Special Provisions and Site of Work. Subcontractor certifies that it has examined the site of the work and that it is familiar with the Owner's plans,

specifications, and the general and special provisions applicable to the prime contract agreement.

Section 27. It is the intention of the parties to this Subcontract that all the provisions of this Agreement apply effective as of the commencement of any work by the Subcontractor regardless of the date of the execution this agreement, however, no payment will be authorized by the Contractor, until Subcontractor properly executes this Agreement, and provides the insurance certificate on the form attached, and returns to the Contractor.

Section 28. Specific Provisions Inserted. The attachment hereto of specific provisions of the Contract between the Contractor and the Owner is for the purpose of emphasis or to comply with applicable law or regulations and is not be construed as an exclusion of other provisions of that Contract.

Section 29. Prior Understanding or Representation. The Contractor assumes no responsibility for any understanding or representations made by any of its officers or agents prior to the execution of this Subcontract, unless such understanding or representations by the Contractor are expressly stated in the Subcontract.

Section 30. Captions. The captions at the beginning of each Section of this Subcontract are for convenience only and are to be given no weight in construing the provisions of this Subcontract.

Section 31. Law to Govern. When this Subcontract is signed by the Contractor, it is to be deemed executed and delivered in the State of Missouri and shall be governed and construed and interpreted in accordance with the laws of the State of Missouri.

Section 32. Jurisdiction, Venue and Limitations. Should either Contractor or Subcontractor institute any suit or action for the enforcement of any of the obligations under this Subcontract, jurisdiction and venue of such suit or action shall be laid in the County of Buchanan and the State of Missouri.

No action shall be maintained against the Contractor upon any claim arising out of or based upon this Subcontract, or by reason of any action, omission or requirement unless commenced within one year after the last work was performed or the material furnished under this Subcontract, or from any alleged breach of this Subcontract.

Section 33. Legal Fees. Should Contractor employ an attorney to enforce any provision of this Subcontract or to collect damages for default or breach of the Subcontract or to recover on any bond required by paragraph 15 hereof, Subcontractor and its sureties agrees to pay Contractor such attorneys' fees and costs of collection as Contractor may expend with respect thereto, and Subcontractor and its sureties waive all rights of exemption. All attorneys' fees and costs of collection shall be covered by said bond(s) required by paragraph 15, and the amount thereof shall increase, and shall be in addition to the penal amount of the bond(s).

Section 34. Dispute Resolution. The parties agree that any disputes that cannot be resolved promptly through informal negotiations (including such means as non-binding mediation at the mutual option of the parties) shall be submitted to binding arbitration. Except as otherwise herein provided, the arbitration shall be conducted by the Arbitrator under the guidance of the Missouri Rules of Civil Procedure, but the Arbitrator shall not be required to comply strictly with such rules in conducting the arbitration. The Arbitrator shall have the authority to adjudicate any dispute between the parties, including without limitation, the imposition of sanctions for abuse or frustration of the arbitration process. The Arbitrator's decision and award shall be reasoned in writing and counterpart copies thereof shall be delivered to each party. The decision and award of the Arbitrator shall be binding on all parties. The Arbitrator is hereby authorized to grant any type of relief allowed in Missouri as if this matter were tried in Circuit Court.

The parties agree that the arbitration will take place in St. Joseph, Missouri, or such other location as the parties and the Arbitrator all agree. The matter will be arbitrated by one person who will be selected by mutual agreement of the parties. If the parties cannot agree on an arbitrator, then the choice of an arbitrator will be submitted to the American Arbitration Association ("AAA") and its rules for choosing an arbitrator shall be followed. It is the intention of the parties that any Arbitrator chosen have substantial construction litigation experience.

The Arbitrator while acting in the official capacity as an arbitrator in this matter shall have the same immunity from liability accorded to Missouri state court judges while acting in their official capacity. The parties agree

that the arbitration award will be final and binding. The parties hereby agree to waive the right to file a demand for trial de novo, and the right to have the dispute heard by a jury. The parties agree that there will be limited discovery in any arbitration. The discovery schedule will be set by the arbitrator but it is the intention of the parties to complete the discovery within a 120 day period. The parties agree that each will be permitted to propound additional written discovery with no more than 25 interrogatories and 25 requests for production to the other; and may take no more than two depositions per party (including a corporate representative deposition). For good cause shown, the Arbitrator within his or her sole discretion may permit either side to take additional depositions or propound additional written discovery.

Unless otherwise agreed herein, this agreement and all proceedings there under shall be subject to the provisions of Missouri Revised Uniform Arbitration Act. Judgment may be entered on the Award rendered in this case, and such judgment may be enforced pursuant to processes available under Missouri law.

The substantially prevailing party shall be awarded attorney fees and costs. The parties agree that the fees and any other expenses charged by the Arbitrator shall be split equally among the parties.

Section 35. Conditions Precedent. This Subcontract shall become binding on Contractor only after Subcontractor has furnished Contractor with the required bonds, Certificates of Insurance and any other documents or items specified in the Subcontract and Prime Contract, and the Subcontractor has been approved by the Engineer, Owner and any other party required so to do by the Prime Contract, and if any of them shall fail or refuse to approve the Subcontractor or if Subcontractor shall fail to produce any item hereinabove specified to be provided, then and in that event this Subcontract at the option of Contractor shall be null, void and of no force or effect and Contractor shall owe nothing further to Subcontractor.

Section 36. Entire Agreement. This writing constitutes the entire agreement between the Contractor and the Subcontractor, and additions, deletions or modification of this Subcontract must be in writing and signed by the parties.

Section 37. Parties. The parties for themselves, their heirs, successors, personal representatives, and assigns do hereby agree to the full performance of the covenants herein.

Section 38. No Presumption Against Drafter. Counsel being available to both parties, the rule that a document shall be construed most strictly to the drafter shall not apply to this Subcontract.

Section 39. Confidential Information. Subcontractor agrees that if Subcontractor receives information or documents which Contractor regards as confidential or proprietary then Subcontractor shall hold such information or documents in strict confidence and shall not use, disclose or duplicate such information or documents except for the performance of this subcontract.

Section 40. Invalidity or Unenforceability. The invalidity or unenforceability of any provision of this Subcontract shall in no way affect the validity or enforceability of any other portion or provision of this Subcontract. The parties agree to amend this Subcontract to replace any invalid or unenforceable provision with a valid or enforceable provision that comes as close as possible to the intent of the invalid or unenforceable provision.

Section 41. Severability and Savings Clause: Whenever possible, each provision of this subcontract shall be interpreted in such a manner to be effective and valid under applicable law, but if any provisions of this subcontract shall be prohibited or invalid under applicable law, such provision shall be ineffective to the extent of such prohibition or invalidity without invalidating the remainder of such provisions of this subcontract. If any void or invalid provision cannot be construed by utilizing the Savings Clause contained in this subcontract to render it enforceable, then any void or invalid provision shall be deemed severed from this subcontract and the balance of this subcontract shall be construed and enforced as if this subcontract did not contain the particular portion or provision held to be void or invalid. Provided, however, the parties further agree to amend this subcontract retroactively to replace any stricken, void or invalid provision with a valid provision which comes as close as possible to the intent of the stricken provision and such replacement term or provision shall retroactively apply back to the date this subcontract was signed.

Section 42. Additional Provisions.

A. Any required submittals shall be an original and 1 electronic copy sent to:

KC Streetcar Constructors
Attn: Andy Auxier
1828 Walnut Street – Suite 500
Kansas City, MO 64108
aauxier@kcsciv.com

B. Whenever possible, each provision of this Subcontract shall be interpreted in such a manner as to be effective and valid under applicable law, but if any provision of this Subcontract shall be prohibited or invalid under applicable law, such provision shall be ineffective to the extent of such prohibition or invalidity without invalidating the remainder of such provisions of this Subcontract. The parties agree to amend this Subcontract to replace any stricken provision with a valid provision that comes as close as possible to the intent of the stricken provision.

C. Subcontractor shall submit the following schedules to Contractor's field office within 7 days as it applies to Subcontractor's work:

1. Schedule of Values – for progress payment purposes;
2. Construction Schedule;
3. Schedule of Required Submittals.

D. Subcontractor's employees shall wear all required personal protective equipment, including, but not limited to, as applicable: hard hats, safety glasses, proper safety shoes, safety vests, etc.

E. Subcontractor shall submit weekly certified payrolls in triplicate beginning with the first week subcontractor furnishes labor for the project and every week thereafter (including zero activity weeks) until completion of the project.

F. Subcontractor shall obtain, complete and transmit to Contractor for Contractor and Owner's review; Current certificate of compliance to the Owner's human relations department (Section 6.10 F.1), Subcontractors Affirmative Action Plan (Section 6.10 F.3), Subcontractor's daily force reports (Section 6.10 I.6), Subcontractor's current certificate of good standing or fictitious name registration from the Missouri Secretary of State. Payment to Subcontractor maybe delayed for failure to be current on its submittal of the requested forms and obligations.

G. Subcontractor shall have its name, acceptable abbreviation or recognizable logo and the name of the City and State of the mailing address of the principle office of the company on each motor vehicle and each piece of equipment.

THIS SUBCONTRACT CONTAINS A BINDING ARBITRATION PROVISION THAT MAY BE ENFORCED BY THE PARTIES.

IN WITNESS WHEREOF, the parties hereto have executed this Subcontract by their proper officers or duly authorized agents.

KC STREETCAR CONSTRUCTORS

BY: _____

BY: _____

Its: _____

Its: _____

Contractor

Subcontractor

License # _____

Exhibit A

This verification of insurance is not an insurance policy and does not amend, extend or alter the coverage afforded by the policies below. Notwithstanding any requirement, term or condition of any contract or other document with respect to which this certificate may be issued or may pertain, the insurance afforded by the policies described herein is subject to all terms, exclusions, and conditions of such policies.

Name and Address of Agency: Phone Number: ()	Companies Affording Coverages: Company Letter A Company Letter B Company Letter C Company Letter D Company Letter E
Name and Address of Insured: Phone Number: ()	

This is to certify that the certificate holder can rely on the fact that policies of insurance and/or endorsements required to affect the coverages herein stipulated, are in force at this time through the policy period so noted.

Co. Ltr.	Types of Insurance	Policy Number	Policy Inception	Policy Expiration	Limits of Liability in Thousands		
						Each	
						Occurrence	Aggregate
	General Liability <input type="checkbox"/> Commercial General Occurrence <input type="checkbox"/> <input type="checkbox"/> Comprehensive Form <input type="checkbox"/> Premises-Operations <input type="checkbox"/> Explosion/Collapse <input type="checkbox"/> Underground <input type="checkbox"/> Products/Completed Operations <input type="checkbox"/> Contractual (Any Contract) <input type="checkbox"/> Broad Form Property Damage <input type="checkbox"/> Independent Contractors <input type="checkbox"/> Personal Injury				Comprehensive Bodily Injury \$..... Property Damage \$..... Combined Single \$..... Personal Injury \$..... Commercial General Aggregate \$..... Products-Comp/Ops \$..... Aggregate \$..... Each Occurrence \$..... Fire Damage \$..... Medical Expense		
	Automobile Liability <input type="checkbox"/> All Owned Autos <input type="checkbox"/> Hired Autos <input type="checkbox"/> Non-Owned Autos				Combined Single Limit \$..... Bodily Injury (Per Person) \$..... Bodily Injury (Per Accident) \$..... Property Damage \$.....		
	Excess Liability <input type="checkbox"/> Umbrella <input type="checkbox"/> Other Form				Each Occurrence \$..... Aggregate \$.....		
	Workers Compensation and Employer's Liability				Statutory \$..... (Each Accident) \$..... (Disease-Policy Limit) \$..... (Disease-Each Employee)		
	Other:						

Referenced Project/State:

General Liability, Automobile Liability and Excess Liability Additional Insured Provisions: KC Streetcar Constructors, its officers, agent employees, volunteers, engineer and owner are added as additional insureds on a primary non-contributory basis to the named insured insurance policies shown above with respect to "any" liability of additional insureds arising out of or resulting from named insured operations performed for the additional insureds, including but not limited to liability of the additional insureds for the general supervision of such operations. Workers Compensation Waivers of Subrogation and Waivers of Statutory Lien Rights: Shall be provided to KC Streetcar Constructors, engineer and owner as respects workers compensation coverage. Workers compensation coverage will apply to all employees, including Executive Officers. Any exclusion pertaining to work within fifty feet (50') of any railroad track shall be deleted.

Name and Address of Certificate Holder: KC Streetcar Constructors 1828 Walnut Street – Suite 500 Kansas City, MO 64108	CANCELLATION: The policies of insurance described above have been amended by endorsement so that should any of those policies be cancelled by the carrier before the expiration date thereof, the issuing company(ies) will mail 30 days written notice to the certificate holder named to the left. Date Issued: _____ _____ Signature of Insurer's Authorized Representative
---	--

SECTION 00830

PREVAILING WAGE

1. Annual Wage Order No. 20
2. **0830.03 Division of Labor Standards Rules & Regulations** are incorporated into and made part of this Contract and are available at <http://www.sos.mo.gov/adrules/csr/current/8csr/8c30-3.pdf>
3. Federal Wage Rates

KANSAS CITY DOWNTOWN STREETCAR

PROJECT NO. 89022000 - 004

SPECIFICATIONS

100% SUBMITTAL

December 2013



Prepared By:
HDR Engineering, Inc.

Prepared For:
City of Kansas City, Missouri

LTK Engineering
Burns & McDonnell
HG Consult
Custom Engineering
TREKK
MDG
RNL

KC STREETCAR - 100% SUBMITTAL SPECIFICATIONS**TABLE OF CONTENTS****DIVISION 00 - PROCUREMENT AND CONTRACTING REQUIREMENTS**

00 01 10 Table of Contents

DIVISION 01 - GENERAL REQUIREMENTS

01 10 00 Summary
 01 11 00 Summary Main Line and Systems
 01 25 00 Substitution Procedures
 01 26 00 Contract Modification Procedures
 01 29 00 Payment Procedures
 01 31 00 Project Management and Coordination
 01 32 00 Construction Progress Documentation
 01 33 00 Submittal Procedures
 01 33 00 Submittal Procedures
 01 40 00 Quality Requirements
 01 42 00 References
 01 43 00 Systems Quality Assurance
 01 50 00 Temporary Facilities and Controls
 01 56 26 Maintenance of Traffic
 01 55 26.13 Maintenance of Traffic
 01 56 39 Temporary Tree and Plant Protection and Pruning
 01 57 13 Erosion Control
 01 60 00 Product Requirements
 01 73 00 Execution
 01 73 29 Cutting and Patching
 01 74 19 Construction Waste Management and Disposal
 01 77 00 Closeout Procedures
 01 78 39 Project Record Documents
 01 81 13.13 Sustainable Design Requirements
 01 91 13 General Commissioning

DIVISION 02 - EXISTING CONDITIONS

02 40 00 Demolition and Structure Moving
 02 41 00 Demolition Disposal
 02 41 13 Removal of Improvements

DIVISION 03 - CONCRETE

03 08 16 Concrete Testing and Evaluation - Contractor
 03 11 00 Concrete Formwork
 03 11 10 Concrete Formwork
 03 15 10 Concrete Flatwork
 03 15 16 Portland Cement Concrete

03 15 23	Expansion Joint Seals in Concrete
03 20 00	Concrete Reinforcing
03 20 10	Concrete Reinforcing
03 25 10	Concrete Joint Control
03 30 00	Cast-in-Place Concrete
03 31 00	Concrete Materials and Proportioning
03 31 05	Structural Concrete
03 31 10	Concrete Mixing, Placing, Jointing and Curing
03 35 00	Concrete Finishing and Repair of Surface Defects
03 35 10	Concrete Finishing
03 35 43	Honed and Polished Concrete Finishing
03 39 00	Concrete Curing
03 45 00	Precast Architectural Concrete
03 53 14	Quartz-Aggregate Concrete Topping - Light Reflective
03 60 00	Grouting
03 64 23	Epoxy Injection Grouting
03 80 00	Concrete Cutting and Boring
03 90 00	Flowable Fill

DIVISION 04 - MASONRY

04 05 05	Cold and Hot Weather Masonry Procedures
04 05 10	Masonry Cleaning
04 05 13	Portland Cement-Lime (PCL) Mortars & Grout
04 05 23	Masonry Accessories
04 22 00	Concrete Masonry

DIVISION 05 - METALS

05 05 05	Galvanic Corrosion Protection
05 12 00	Structural Steel Framing
05 12 10	Structural Steel
05 12 13	Architecturally Exposed Structural Steel
05 21 10	Steel Joists
05 31 23	Metal Roof Decking
05 36 00	Composite Metal Form Deck
05 40 00	Cold-Formed Metal Framing
05 50 00	Metal Fabrications
05 50 10	Miscellaneous Metal Fabrications
05 50 13	Steel Stairs and Railings
05 51 19	Metal Grating Stairs
05 52 14	Steel Pipe Railings
05 53 13	Steel Bar Gratings
05 58 00	Sheet Metal Panels
05 73 13	Glass Railings

DIVISION 06 - WOOD, PLASTICS AND COMPOSITES

06 10 53	Miscellaneous Rough Carpentry
06 16 43.01	Gypsum Wall Sheathing

06 40 23	Interior Architectural Woodwork
06 64 00	Plastic Paneling
06 74 13	Glass-Fiber-Reinforced Plastic Gratings

DIVISION 07 - THERMAL AND MOISTURE PROTECTION

07 13 26	Self-Adhering Sheet Waterproofing
07 21 13	Foam Board Foundation Insulation
07 21 14	Continuous Mineral Board Wall Insulation
07 21 16	Blanket Insulation
07 25 00	Weather Barriers
07 42 13.04	Concealed-Fastener Lap Seam Metal Wall Panels
07 42 16	Insulated Core Metal Wall Panels
07 54 23	Thermoplastic Polyolefin (TPO) Roofing
07 62 00	Sheet Metal Flashing and Trim
07 72 33	Roof Hatches
07 84 13	Penetration Firestopping
07 84 46	Fire-Resistive Joint Systems for Walls
07 92 00	Joint Sealants
07 92 13	Exterior Joint Sealants

DIVISION 08 - OPENINGS

08 11 13	Hollow Metal Doors and Frames
08 14 16	Wood-Veneer Faced Solid Core Flush Wood Doors
08 31 13	Access Doors and Frames
08 31 21	Sliding Glass Door Track
08 33 23	Overhead Coiling Doors
08 33 25	Overhead Coiling Counter Doors
08 34 19	Industrial Four-Fold Doors
08 36 13.10	Steel Sectional Doors
08 41 13	Aluminum-Framed Entrances and Storefronts
08 41 23	Aluminum-Framed Interior Storefronts
08 62 14	Domed Tubular Unit Skylights
08 71 00	Door Hardware
08 80 00	Glazing
08 81 00	Glass and Glazing
08 83 00	Mirrors
08 84 00	Plastic Glazing

DIVISION 09 - FINISHES

09 22 16	Non-Structural Metal Framing
09 29 00	Gypsum Board
09 30 00	Tiling
09 51 13	Acoustical Panel Ceilings
09 61 13	Cast in Place Tactile Warning Surface Tiles
09 65 13	Resilient Base and Accessories
09 65 16.13	Linoleum Sheet Flooring
09 65 19	Resilient Tile Flooring

09 65 19.02	Rubber Tile Flooring
09 67 23	Resinous Flooring - Rhino
09 68 13	Tile Carpeting
09 91 13	Exterior Painting
09 91 13.10	Exterior Painting
09 91 23	Interior Painting

DIVISION 10 - SPECIALTIES

10 11 16	Markerboards
10 11 46.04	Visual Display Wall Coverings - Tackable
10 14 00	Traffic Signage
10 14 19	Dimensional Letter Signage
10 14 23	Panel Signage
10 14 53	Traffic Signing
10 21 13	Solid-Polymer Toilet Compartments
10 26 13	Stainless Steel Corner Guards
10 28 13	Commercial Toilet Accessories
10 41 16	Fire Department Key Box
10 44 13	Portable Fire Extinguisher Cabinets
10 44 16	Portable Multipurpose Dry-Chemical Fire Extinguishers
10 51 13	Standard Metal Lockers
10 56 00	Storage Equipment

DIVISION 11 - EQUIPMENT

11 11 00	Vehicle Service Equipment
11 11 26	Vehicle Wash Equipment
11 11 29	Vehicle Shop Equipment
11 31 00	Residential Appliances

DIVISION 12 - FURNISHINGS

12 24 13	Roller Window Shades
12 36 16.01	Stainless Steel Countertops
12 48 16	Entrance Floor Grilles
12 93 00	Site Furnishings
12 93 10	Benches
12 93 43	Precast Concrete Site Benches

DIVISION 13 - STATION PLATFORMS

13 13 50	Station Platforms
----------	-------------------

DIVISIONS 14 - CONVEYING EQUIPMENT

14 21 44	Machine Room-Less Electric Traction Passenger Elevators
14 45 00	Vehicle Lifts

DIVISIONS 15 THRU 20 - NOT USED**DIVISION 21 - FIRE SUPPRESSION**

- 21 05 17 Sleeves and Sleeve Seals For Fire-Suppression Piping
- 21 05 18 Escutcheons For Fire-Suppression Piping
- 21 13 13 Wet-Pipe Sprinkler Systems
- 21 21 16 Low-Pressure, Carbon-Dioxide Fire-Extinguishing Systems

DIVISION 22 - PLUMBING

- 22 05 17 Sleeves and Sleeve Seals For Plumbing Piping
- 22 05 18 Escutcheons For Plumbing Piping
- 22 05 19 Meters and Gages For Plumbing Piping
- 22 05 23 General Duty Valves For Plumbing Piping
- 22 05 29 Hangers and Supports For Plumbing Piping and Equipment
- 22 05 53 Identification For Plumbing Piping and Equipment
- 22 07 19 Plumbing Piping Insulation
- 22 11 16 Domestic Water Piping
- 22 11 19 Domestic Water Piping Specialties
- 22 11 23 Domestic Water Pumps
- 22 13 16 Sanitary Waste and Vent Piping
- 22 13 19 Sanitary Waste Piping Specialties
- 22 13 23 Sanitary Waste Interceptors
- 22 14 13 Facility Storm Drainage Piping
- 22 14 23 Facility Storm Drainage Specialties
- 22 14 29 Sump Pumps
- 22 34 00 Fuel-Fired, Domestic-Water Heaters
- 22 42 13.13 Commercial Water Closets
- 22 42 13.16 Commercial Urinals
- 22 42 16.13 Commercial Lavatories
- 22 42 16.16 Commercial Sinks
- 22 42 23 Commercial Showers
- 22 45 00 Emergency Plumbing Fixtures
- 22 47 16 Pressure Water Coolers

DIVISION 23 - HEATING, VENTILATING, AND AIR-CONDITIONING (HVAC)

- 23 05 13 Common Motor Requirements for HVAC Equipment
- 23 05 29 Hangers and Supports for HVAC Piping and Equipment
- 23 05 93 Testing, Adjusting, and Balancing for HVAC
- 23 07 13 Duct Insulation
- 23 07 19 HVAC Piping Insulation
- 23 08 00 Commissioning of HVAC
- 23 09 00 Instrumentation and Control for HVAC
- 23 11 23 Facility Natural-Gas Piping
- 23 23 00 Refrigerant Piping
- 23 31 13 Metal Ducts
- 23 31 16 Nonmetal Ducts
- 23 33 00 Air Duct Accessories

23 34 23	HVAC Power Ventilators
23 37 13	Diffusers, Registers, and Grilles
23 51 00	Vents and Flues
23 55 23	Low-Intensity, Gas-Fired, Radiant Heaters
23 62 00	Packaged Compressor and Condenser Units
23 74 33	Dedicated Outdoor Air Units
23 82 19	Fan Coil Units

DIVISIONS 24 THRU 25 - NOT USED**DIVISION 26 - ELECTRICAL**

26 05 00.13	Systemwide Electrical General Requirements for Systems
26 05 19	Low-Voltage Electrical Power
	Systemwide Electrical Low-Voltage Electrical Power Conductors and Cables for
26 05 19.13	Systems
26 05 26	Grounding and Bonding for Electrical Systems
26 05 26.13	Systemwide Electrical Grounding for Systems
26 05 29.13	Systemwide Electrical Raceway and Equipment Supports for Systems
26 05 29	Hangers and Supports for Electrical Systems
26 05 33	Raceways and Boxes for Electrical Systems
26 05 33.13	Systemwide Electrical Raceways for Systems
26 05 43	Systemwide Electrical Underground Ductbanks and Raceways for Systems
26 05 43	Underground Ducts
26 05 44	Systemwide Electrical Manholes and Handholes for Systems
26 05 44	Sleeves and Sleeve Seals
26 05 53	Identification for Electrical Systems
26 05 73	Overcurrent Protective Device Coordination Study
26 05 74	Arc Flash Analysis
26 08 10	Systemwide Electrical Testing for Systems
26 09 23	Lighting Control Devices
26 22 00	Low-Voltage Transformers
26 24 13	Switchboards
26 24 16	Panelboards
26 27 26	Wiring Devices
26 28 16	Enclosed Switches and Circuit Breakers
26 29 13	Enclosed Controllers
26 41 13	Lightning Protection for Structures
26 42 00	Track Slab Electrical Continuity
26 42 12	Track Electrical Isolation
26 42 14	Cathodic Protection for New or Relocated Waterlines - Systems Copy
26 43 13	Transient-Voltage Suppression for Panelboards
26 51 00	Interior Lighting
26 56 00	Exterior Lighting
26 56 10	Station Stop Lighting

DIVISION 27 - COMMUNICATIONS

27 51 23	Intercommunications Systems
----------	-----------------------------

DIVISION 28 - ELECTRONIC SAFETY AND SECURITY

- 28 05 13 Conductors and Cables for Electronic Safety and Security
- 28 31 11 Digital, Addressable Fire-Alarm System

DIVISIONS 29 THRU 30 - NOT USED**DIVISION 31 - EARTHWORK**

- 31 05 19.13 Geotextile Fabric, Geocomposites and Ballast Mats
- 31 13 00 Tree Removal
- 31 22 00 Site Preparation and Grading
- 31 22 19 Finish Grading
- 31 23 00 Building Excavation, Filling, and Backfilling
- 31 23 13 Subgrade Preparation
- 31 23 16.16 Structural Excavation and Backfill
- 31 23 33 Trenching, Backfilling and Compacting for Utilities
- 31 25 00 Erosion and Sedimentation Controls
- 31 34 19 Geosynthetic Reinforced Soil Slope System
- 31 37 00 Riprap
- 31 41 00 Shoring
- 31 63 29 Drilled Piers
- 31 66 13.15 Rammed Pier Ground Improvement

DIVISION 32 - EXTERIOR IMPROVEMENTS

- 32 01 16.71 Cold Milling Asphalt Paving
- 32 01 29.13 Damaged Concrete Removal and Patching
- 32 01 29.16 Delamination Repair
- 32 01 90 Operation and Maintenance of Planting
- 32 11 00 Aggregate Base Course
- 32 11 00 Untreated Compacted Aggregate
- 32 12 13.19 Prime Coats
- 32 12 16.10 Asphalt Concrete Pavement
- 32 12 16.39 Profilograph and Pavement Smoothness
- 32 12 16.50 Temporary Surfacing
- 32 13 13 Portland Cement Concrete Pavement
- 32 13 13.10 Portland Cement Concrete Pavement - ML
- 32 14 13 Precast Concrete Unit Paving
- 32 14 43 Porous Precast Concrete Unit Paving Aggregate Bed Set
- 32 15 43 Stone Surfacing
- 32 16 13 Curbing
- 32 16 23 Standard Sidewalks, Sidewalk Ramps, Driveways, and Bicycle & Pedestrian Paths
- 32 16 23.10 Sidewalks, Driveways, and Curbs - ML
- 32 17 23 Pavement Marking Materials
- 32 17 23.10 Temporary Pavement Markings
- 32 31 00 Fences and Gates
- 32 31 16 Welded Wire Fences and Gates

32 84 00	Planting Irrigation
32 91 00	Planting Preparation
32 92 00	Prairie Grasses and Wildflowers
32 93 00	Plants
32 94 13	Aluminum Landscape Edging

DIVISION 33 - UTILITIES

33 01 00	Operation and Maintenance of Utilities
33 05 13.13	Adjustment of Incidental Structures
33 05 16	Utility Adjustments
33 11 13.13	Ductile Iron Pipe Water Main
33 13 00	Watermain Testing, Disinfection, and Dechlorination
33 31 13	PVC Gravity Sewer
33 39 13	Sanitary Sewer Manhole Construction
33 40 00	Storm Drainage Utilities
33 41 13	Reinforced Concrete Pipe
33 41 14	HDPE Storm Sewer Pipe
33 44 19	Utility Storm Water Treatment
33 44 19.16	Catch Basin Insert Utility Storm Water Filters
33 46 00	Subdrainage
33 46 16.19	Underdrains
33 49 13	Storm Structures

DIVISION 34 - TRANSPORTATION

34 11 00	Rail
34 11 16	Trackwork - Field Rail Welding
34 11 23	Special Track Work
34 11 29	General Track Construction
34 11 93	Other Track Materials
34 21 05	Common Work Results for Traction Electrification System (TES)
34 21 06	TES Common Work Results for Metals
34 21 08	TES Dielectric Epoxy Flooring
34 21 10	TES Self Contained Eyewash Equipment
34 21 12	TES Low-Voltage Panelboards
34 21 13	TES Switchboards
34 21 14	TES MV AC CB Switchgear
34 21 16	TES Substation Enclosures
34 21 17	TES Substation Design and Assembly
34 21 18	TES Lighting
34 21 19	TES DC Switchgear
34 21 23	TES Transformer-Rectifier Unit
34 21 24	TES Dry Type Transformers
34 21 25	TES DC Control Power
34 21 31	TES Substation Automation System (SAS)
34 21 33	TES Rail-Voltage Monitoring and Grounding System
34 21 40	TES DC Disconnect Switches
34 21 46	TES VMS AC Motor Control Center
34 21 50	TES DC Surge Arrestors

34 21 70	VMF TES Control and APS
34 21 73	TES Studies
34 21 75	TES System Assurance
34 21 80	TES Spare Parts and Special Tools
34 21 90	TES Testing
34 21 95	TES Operation and Maintenance Data
34 21 96	TES Project Record Documents
34 21 97	TES Demonstration and Training
34 22 05	TES CWR for Conductors and Cable
34 22 10	TES Low-Voltage Conductors and Cable
34 22 15	TES Fiber Optic Cable
34 22 20	TES Rail Bonding
34 22 26	TES Grounding and Bonding
34 22 29	TES Raceway and Equip Hangers and Supports
34 22 33	TES Raceway and Boxes
34 23 10	OCS Description and General Requirements
34 23 11.01	OCS Glossary of Standard Terms
34 23 35.99	OCS Pole Painting
34 23 37	OCS Tubular Steel Poles
34 23 37.11	OCS Pole Ornamentation
34 23 40	OCS Wire and Cable
34 23 50	OCS Assemblies, Components and Fittings
34 23 64	OCS Special Tools
34 23 66	OCS Spare Parts
34 23 70	OCS Installation
34 23 71	OCS Pole Foundations
34 23 72	OCS Tubular Pole Installation
34 23 77	OCS Surge Arrester Installation
34 23 78	OCS Disconnect Switch Installation
34 23 80	OCS Testing
34 23 90	OCS Installation Records
34 23 96	OCS Installation and Maintenance Manuals
34 23 97	OCS Maintenance Staff Training
34 42 10	Signals General Engineering and Design Requirements
34 42 11	Signals General Installation Requirements
34 42 16	Signals Wire and Cable
34 42 19	Signals Microprocessor Systems
34 42 25	Signals Relays and Plugboards
34 42 29	Signals Electrical and Electronic Components
34 42 33	Signals Prefabricated Relay Cases
34 42 36	Signals Switch Point Heaters
34 42 40	Signals Tags Locks and Keys
34 42 44	Signals Power Distribution
34 42 52	Signals Power Switch and Lock Machines
34 42 56	Signal Layouts
34 42 58	Signals Track Circuits and Bonding
34 42 60	Signals Train to Wayside Communications
34 42 68	Signals Circuit and Operational Requirements
34 42 72	Signals Spare Parts, Manuals and Training
34 42 76	Signals Tests and Inspections

DIVISION 41 - MATERIAL PROCESSING AND HANDLING EQUIPMENT

41 22 00 Hoists and Cranes

DIVISION 45 - INDUSTRY-SPECIFIC MANUFACTURING EQUIPMENT

45 39 00 Fabricated Shop Equipment

SECTION 01 10 00**SUMMARY****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY**A. Section Includes:**

- 1. Project information.
- 2. Work covered by Contract Documents.
- 3. Access to site.
- 4. Work restrictions.
- 5. Specification and drawing conventions.
- 6. Miscellaneous provisions.

B. Related Requirements:

- 1. Section 01 50 00 "Temporary Facilities and Controls" for limitations and procedures governing temporary use of Owner's facilities.

1.03 PROJECT INFORMATION**A. Project Identification: Kansas City Downtown Streetcar VMF.**

- 1. Project Location: XXXX Holmes Street, Kansas City, Missouri.

B. Owner: Kansas City, Missouri

- 1. Owner's Representative: Ralph Davis, City Engineer, Kansas City Public Works Department.

C. Architect: RNL Design, 1050 17th Street, Denver, CO 80265**D. The Work of Project is defined by the Contract Documents and consists of the following:**

- 1. The Work consists of a new Vehicle Maintenance Facility for the Kansas City Downtown Streetcar Transit System. The Work will include precast and unit masonry walls, exterior metal panels on cold-formed metal framing, steel structure and metal roof deck. The Work also includes steel and steel grating stairs, an elevator, and a parts lift. The Work includes mechanical and electrical systems, including fire suppression and communications throughout the facility. The Work also includes aluminum storefront system and insulated glazing, all interior finishes, site work, landscaping, and site furnishings.

E. Type of Contract:

- 1. Project will be constructed under a single prime contract.

- F. Buy American: This project is required to abide by the latest update of the Buy American Act.

1.04 ACCESS TO SITE

- A. General: Contractor shall have full use of Project site for construction operations during construction period. Contractor's use of Project site is limited only by Owner's right to perform work or to retain other contractors on portions of Project.

1.05 WORK RESTRICTIONS

- A. Work Restrictions, General: Comply with restrictions on construction operations.
1. Comply with limitations on use of public streets and with other requirements of authorities having jurisdiction.
- B. On-Site Work Hours: Limit work in the existing building to normal business working hours of <Insert time> a.m. to <Insert time> p.m., Monday through Friday, unless otherwise indicated.
- C. Noise, Vibration, and Odors: Coordinate operations that may result in high levels of noise and vibration, odors, or other disruption to Owner occupancy with Owner.
1. Notify Architect not less than two days in advance of proposed disruptive operations.
 2. Obtain Architect's written permission before proceeding with disruptive operations.
- D. Controlled Substances: Use of tobacco products and other controlled substances on Project site is not permitted.
- E. Employee Identification: Provide identification tags for Contractor personnel working on Project site. Require personnel to use identification tags at all times.
- F. Employee Screening: Comply with Owner's requirements for drug and background screening of Contractor personnel working on Project site.
1. Maintain list of approved screened personnel with Owner's representative.

1.06 SPECIFICATION AND DRAWING CONVENTIONS

- A. Specification Content: The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:
1. Imperative mood and streamlined language are generally used in the Specifications. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.
 2. Specification requirements are to be performed by Contractor unless specifically stated otherwise.
- B. Division 01 General Requirements: Requirements of Sections in Division 01 apply to the Work of all Sections in the Specifications.
- C. Specification Revisions: From time to time these Specifications may be revised to indicate changes to the Contract Requirements. The following conventions will be used to indicate changes to these Specifications. The Contractor shall post the changes on the Record Specifications.

1. Revision number, date and other information indicating how specification changes are issued to Contractor will be indicated in the upper right-hand corner of header of each section.
 2. Language added to these Specifications will be underlined (underlined).
 3. Language deleted from these Specification will be struck out (struck out).
 4. Revision numbers will be indicated at the end of sentences and paragraphs where language is added, deleted or changed. See upper right-hand corner of page for date of revision.
 5. Language added and deleted will be indicated by vertical bar on right margin of page (|).
 6. Revised specifications may be issued to Contractor by one or more of the following means:
 - a. A complete section including all pages showing changes as well as those not showing changes, usually when revisions are extensive and when page numbering changes.
 - b. Selected pages of a section where revisions do not change pagination.
 - c. Abbreviated section showing language that has been revised and showing additional language for context (to help the reader locate language that has been revised). Language not shown shall remain as indicated on previous versions of the section. Abbreviated sections are issued usually when revisions are indicated on few pages of the complete version of the section.
 7. All persons reading the Specifications shall refer to previous versions and revisions of the Specifications to determine what changes were made to each succeeding version or revision.
- D. Drawing Coordination: Requirements for materials and products identified on Drawings are described in detail in the Specifications. One or more of the following are used on Drawings to identify materials and products:
1. Terminology: Materials and products are identified by the typical generic terms used in the individual Specifications Sections.
 2. Abbreviations: Materials and products are identified by abbreviations published as part of the U.S. National CAD Standard and scheduled on Drawings.
 3. Keynoting: Materials and products are identified by reference keynotes referencing Specification Section numbers found in this Project Manual.

1.07 MISCELLANEOUS PROVISIONS

- A. Correction Period: General Contractor's correction period shall extend for a minimum 2 years from date of Substantial Completion. General Contractor shall coordinate requirements for extended correction period with Work required by the Contract Documents.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 10 00

SECTION 01 11 00**SUMMARY MAIN LINE AND SYSTEMS****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the CM/GC Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY**A. Section Includes:**

- 1. Project information.
- 2. Work covered by Contract Documents.
- 3. Access to site.
- 4. Work restrictions.
- 5. Specification and drawing conventions.
- 6. Miscellaneous provisions.

B. Related Requirements:

- 1. Section 01 50 00 "Temporary Facilities and Controls" for limitations and procedures governing temporary use of Owner's facilities.

1.03 PROJECT INFORMATION**A. Project Identification: Kansas City Downtown Streetcar Main Line and Systems.**

- 1. Project Location: Main Street from River Market District to Pershing Road, Kansas City, Missouri.

B. Owner: Kansas City, Missouri

- 1. Owner's Representative: Ralph Davis, City Engineer, Kansas City Public Works Department.

C. Engineer: HDR Engineering, Inc., 4435 Main Street, Suite 1000, Kansas City, MO 64111**D. The Work of Project is defined by the Contract Documents and consists of the following:**

- 1. The Work consists of a new Main Line Tracks and Station Stops for the Kansas City Downtown Streetcar Transit System. The Work will include embedded track in the existing streets, station stops, utility relocation, bridge modifications, OCS, signals, and traction power.

E. Type of Contract:

- 1. Project will be constructed under a single prime CM/GC contract.

F. Buy American: This project is required to abide by the latest update of the Buy American Act.

1.04 ACCESS TO SITE

- A. General: Contractor shall coordinate their use of Project site with vehicle and pedestrian traffic for construction operations during construction period. Contractor's use of Project site is also limited by Owner's right to perform work or to retain other contractors on portions of Project.

1.05 WORK RESTRICTIONS

- A. Work Restrictions, General: Comply with restrictions on construction operations.
 - 1. Comply with limitations on use of public streets and with other requirements of authorities having jurisdiction.
- B. Noise, Vibration, and Odors: Coordinate operations that may result in high levels of noise and vibration, odors, or other disruption to Owner occupancy with Owner.
 - 1. Notify Engineer not less than two days in advance of proposed disruptive operations.
 - 2. Obtain Engineer's written permission before proceeding with disruptive operations.
- C. Controlled Substances: Use of tobacco products and other controlled substances on Project site is not permitted.
- D. Employee Identification: Provide identification tags for Contractor personnel working on Project site. Require personnel to use identification tags at all times.
- E. Employee Screening: Comply with Owner's requirements for drug and background screening of Contractor personnel working on Project site.
 - 1. Maintain list of approved screened personnel with Owner's representative.

1.06 SPECIFICATION AND DRAWING CONVENTIONS

- A. Specification Content: The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:
 - 1. Imperative mood and streamlined language are generally used in the Specifications. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.
 - 2. Specification requirements are to be performed by Contractor unless specifically stated otherwise.
- B. Division 01 General Requirements: Requirements of Sections in Division 01 apply to the Work of all Sections in the Specifications.
- C. Specification Revisions: From time to time these Specifications may be revised to indicate changes to the Contract Requirements. The following conventions will be used to indicate changes to these Specifications. The Contractor shall post the changes on the Record Specifications.
 - 1. Revision number, date and other information indicating how specification changes are issued to Contractor will be indicated in the upper right-hand corner of header of each section.
 - 2. Language added to these Specifications will be underlined (underlined).
 - 3. Language deleted from these Specification will be struck out (struck out).

4. Revision numbers will be indicated at the end of sentences and paragraphs where language is added, deleted or changed. See upper right-hand corner of page for date of revision.
 5. Language added and deleted will be indicated by vertical bar on right margin of page (|).
 6. Revised specifications may be issued to Contractor by one or more of the following means:
 - a. A complete section including all pages showing changes as well as those not showing changes, usually when revisions are extensive and when page numbering changes.
 - b. Selected pages of a section where revisions do not change pagination.
 - c. Abbreviated section showing language that has been revised and showing additional language for context (to help the reader locate language that has been revised). Language not shown shall remain as indicated on previous versions of the section. Abbreviated sections are issued usually when revisions are indicated on few pages of the complete version of the section.
 7. All persons reading the Specifications shall refer to previous versions and revisions of the Specifications to determine what changes were made to each succeeding version or revision.
- D. Drawing Coordination: Requirements for materials and products identified on Drawings are described in detail in the Specifications. One or more of the following are used on Drawings to identify materials and products:
1. Terminology: Materials and products are identified by the typical generic terms used in the individual Specifications Sections.
 2. Abbreviations: Materials and products are identified by abbreviations published as part of the U.S. National CAD Standard and scheduled on Drawings.
 3. Keynoting: Materials and products are identified by reference keynotes referencing Specification Section numbers found in this Project Manual.

1.07 MISCELLANEOUS PROVISIONS

- A. Correction Period: General Contractor's correction period shall extend for a minimum 2 years from date of Substantial Completion. General Contractor shall coordinate requirements for extended correction period with Work required by the Contract Documents.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 11 00

SECTION 01 25 00**SUBSTITUTION PROCEDURES****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section includes administrative and procedural requirements for substitutions.
- B. Related Requirements:
 - 1. Section 01 60 00 "Product Requirements" for requirements for submitting comparable product submittals for products by listed manufacturers.

1.03 DEFINITIONS

- A. Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor.
 - 1. Substitutions for Cause: Changes proposed by Contractor that are required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms.
 - 2. Substitutions for Convenience: Changes proposed by Contractor or Owner that are not required in order to meet other Project requirements but may offer advantage to Contractor or Owner.

1.04 ACTION SUBMITTALS

- A. Substitution Requests: Submit three copies of each request for consideration. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
 - 1. Substitution Request Form: Use [facsimile of form provided in Project Manual].
 - 2. Documentation: Show compliance with requirements for substitutions and the following, as applicable:
 - a. Statement indicating why specified product or fabrication or installation cannot be provided, if applicable.
 - b. Coordination information, including a list of changes or revisions needed to other parts of the Work and to construction performed by Owner and separate contractors, that will be necessary to accommodate proposed substitution.
 - c. Detailed comparison of significant qualities of proposed substitution with those of the Work specified. Include annotated copy of applicable Specification Section. Significant qualities may include attributes such as performance, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements indicated. Indicate deviations, if any, from the Work specified.
 - d. Product Data, including drawings and descriptions of products and fabrication and installation procedures.

- e. Samples, where applicable or requested.
 - f. Certificates and qualification data, where applicable or requested.
 - g. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners.
 - h. Material test reports from a qualified testing agency indicating and interpreting test results for compliance with requirements indicated.
 - i. Research reports evidencing compliance with building code in effect for Project, from ICC-ES.
 - j. Detailed comparison of Contractor's construction schedule using proposed substitution with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating date of receipt of purchase order, lack of availability, or delays in delivery.
 - k. Cost information, including a proposal of change, if any, in the Contract Sum.
 - l. Contractor's certification that proposed substitution complies with requirements in the Contract Documents except as indicated in substitution request, is compatible with related materials, and is appropriate for applications indicated.
 - m. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.
3. Architect's Action: If necessary, Architect will request additional information or documentation for evaluation within seven days of receipt of a request for substitution. Architect will notify Contractor of acceptance or rejection of proposed substitution within 15 days of receipt of request, or seven days of receipt of additional information or documentation, whichever is later.
 - a. Forms of Acceptance: Change Order, Construction Change Directive, or Architect's Supplemental Instructions for minor changes in the Work.
 - b. Use product specified if Architect does not issue a decision on use of a proposed substitution within time allocated.

1.05 QUALITY ASSURANCE

- A. Compatibility of Substitutions: Investigate and document compatibility of proposed substitution with related products and materials. Engage a qualified testing agency to perform compatibility tests recommended by manufacturers.

1.06 PROCEDURES

- A. Coordination: Revise or adjust affected work as necessary to integrate work of the approved substitutions.

PART 2 - PRODUCTS

2.01 SUBSTITUTIONS

- A. Substitutions for Cause: Submit requests for substitution immediately on discovery of need for change, but not later than 15 days prior to time required for preparation and review of related submittals.
 1. Conditions: Architect will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Architect will return requests without action, except to record noncompliance with these requirements:

- a. Requested substitution is consistent with the Contract Documents and will produce indicated results.
 - b. Requested substitution provides sustainable design characteristics that specified product provided for achieving LEED prerequisites and credits.
 - c. Substitution request is fully documented and properly submitted.
 - d. Requested substitution will not adversely affect Contractor's construction schedule.
 - e. Requested substitution has received necessary approvals of authorities having jurisdiction.
 - f. Requested substitution is compatible with other portions of the Work.
 - g. Requested substitution has been coordinated with other portions of the Work.
 - h. Requested substitution provides specified warranty.
 - i. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.
- B. Substitutions for Convenience: Architect will consider requests for substitution if received within 60 days after the Notice to Proceed. Requests received after that time may be considered or rejected at discretion of Architect.
1. Conditions: Architect will consider Contractor's request for substitution when all of the following conditions are satisfied. If the following conditions are not satisfied, Architect will return requests without action, except to record noncompliance with these requirements:
 - a. Requested substitution offers Owner a substantial advantage in cost, time, energy conservation, or other considerations, after deducting additional responsibilities Owner must assume. Owner's additional responsibilities may include compensation to Architect for evaluation services, increased cost of other construction by Owner, and similar considerations.
 - b. Requested substitution does not require revisions to the Contract Documents.
 - c. Requested substitution is consistent with the Contract Documents and will produce indicated results.
 - d. Requested substitution provides sustainable design characteristics that specified product provided for achieving LEED prerequisites and credits.
 - e. Substitution request is fully documented and properly submitted.
 - f. Requested substitution will not adversely affect Contractor's construction schedule.
 - g. Requested substitution has received necessary approvals of authorities having jurisdiction.
 - h. Requested substitution is compatible with other portions of the Work.
 - i. Requested substitution has been coordinated with other portions of the Work.
 - j. Requested substitution provides specified warranty.
 - k. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 25 00

SECTION 01 26 00**CONTRACT MODIFICATION PROCEDURES****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section includes administrative and procedural requirements for handling and processing Contract modifications.
- B. Related Requirements:
 - 1. Section 01 25 00 "Substitution Procedures" for administrative procedures for handling requests for substitutions made after the Contract award.

1.03 MINOR CHANGES IN THE WORK

- A. Architect will issue supplemental instructions authorizing minor changes in the Work, not involving adjustment to the Contract Sum or the Contract Time, on form included in Project Manual.

1.04 PROPOSAL REQUESTS

- A. Owner-Initiated Proposal Requests: Architect will issue a detailed description of proposed changes in the Work that may require adjustment to the Contract Sum or the Contract Time. If necessary, the description will include supplemental or revised Drawings and Specifications.
 - 1. Work Change Proposal Requests issued by Architect are not instructions either to stop work in progress or to execute the proposed change.
 - 2. Within time specified in Proposal Request or 20 days, when not otherwise specified, after receipt of Proposal Request, submit a quotation estimating cost adjustments to the Contract Sum and the Contract Time necessary to execute the change.
 - a. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
 - b. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
 - c. Include costs of labor and supervision directly attributable to the change.
 - d. Include an updated Contractor's construction schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.
 - e. Quotation Form: Use forms acceptable to Architect.
- B. Contractor-Initiated Proposals: If latent or changed conditions require modifications to the Contract, Contractor may initiate a claim by submitting a request for a change to Architect.

1. Include a statement outlining reasons for the change and the effect of the change on the Work. Provide a complete description of the proposed change. Indicate the effect of the proposed change on the Contract Sum and the Contract Time.
2. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
3. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
4. Include costs of labor and supervision directly attributable to the change.
5. Include an updated Contractor's construction schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.
6. Comply with requirements in Section 01 25 00 "Substitution Procedures" if the proposed change requires substitution of one product or system for product or system specified.
7. Proposal Request Form: Use form acceptable to Architect.

1.05 CHANGE ORDER PROCEDURES

- A. On Owner's approval of a Work Changes Proposal Request, Architect will issue a Change Order for signatures of Owner and Contractor on form included in Project Manual.

1.06 CONSTRUCTION CHANGE DIRECTIVE

- A. Construction Change Directive: Architect may issue a Construction Change Directive on form included in Project Manual. Construction Change Directive instructs Contractor to proceed with a change in the Work, for subsequent inclusion in a Change Order.
 1. Construction Change Directive contains a complete description of change in the Work. It also designates method to be followed to determine change in the Contract Sum or the Contract Time.
- B. Documentation: Maintain detailed records on a time and material basis of work required by the Construction Change Directive.
 1. After completion of change, submit an itemized account and supporting data necessary to substantiate cost and time adjustments to the Contract.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 26 00

SECTION 01 29 00**PAYMENT PROCEDURES****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section includes administrative and procedural requirements necessary to prepare and process Applications for Payment.
- B. Related Requirements:
 - 1. Section 01 26 00 "Contract Modification Procedures" for administrative procedures for handling changes to the Contract.
 - 2. Section 01 32 00 "Construction Progress Documentation" for administrative requirements governing the preparation and submittal of the Contractor's construction schedule.
 - 3. Section 01 81 13 "Sustainable Design Requirements."

1.03 DEFINITIONS

- A. Schedule of Values: A statement furnished by Contractor allocating portions of the Contract Sum to various portions of the Work and used as the basis for reviewing Contractor's Applications for Payment.

1.04 SCHEDULE OF VALUES

- A. Coordination: Coordinate preparation of the schedule of values with preparation of Contractor's construction schedule.
 - 1. Coordinate line items in the schedule of values with other required administrative forms and schedules, including the following:
 - a. Application for Payment forms with continuation sheets.
 - b. Submittal schedule.
 - c. Items required to be indicated as separate activities in Contractor's construction schedule.
 - 2. Submit the schedule of values to Architect at earliest possible date, but no later than seven days before the date scheduled for submittal of initial Applications for Payment.
- B. Format and Content: Use Project Manual table of contents as a guide to establish line items for the schedule of values. Provide at least one line item for each Specification Section.
 - 1. Identification: Include the following Project identification on the schedule of values:
 - a. Project name and location.
 - b. Name of Architect.

- c. Architect's project number.
 - d. Contractor's name and address.
 - e. Date of submittal.
2. Arrange the schedule of values in tabular form with separate columns to indicate the following for each item listed:
 - a. Related Specification Section or Division.
 - b. Description of the Work.
 - c. Name of subcontractor.
 - d. Name of manufacturer or fabricator.
 - e. Name of supplier.
 - f. Change Orders (numbers) that affect value.
 - g. Dollar value of the following, as a percentage of the Contract Sum to nearest one-hundredth percent, adjusted to total 100 percent.
 - 1) Labor.
 - 2) Materials.
 - 3) Equipment.
3. Provide a breakdown of the Contract Sum in enough detail to facilitate continued evaluation of Applications for Payment and progress reports. Coordinate with Project Manual table of contents. Provide multiple line items for principal subcontract amounts in excess of five percent of the Contract Sum.
 - a. Include separate line items under principal subcontracts for LEED documentation and other Project closeout requirements in an amount totaling five percent of the Contract Sum and subcontract amount.
4. Round amounts to nearest whole dollar; total shall equal the Contract Sum.
5. Provide a separate line item in the schedule of values for each part of the Work where Applications for Payment may include materials or equipment purchased or fabricated and stored, but not yet installed.
 - a. Differentiate between items stored on-site and items stored off-site. If required, include evidence of insurance.
6. Provide separate line items in the schedule of values for initial cost of materials, for each subsequent stage of completion, and for total installed value of that part of the Work.
7. Allowances: Provide a separate line item in the schedule of values for each allowance. Show line-item value of unit-cost allowances, as a product of the unit cost, multiplied by measured quantity. Use information indicated in the Contract Documents to determine quantities.
8. Purchase Contracts: Provide a separate line item in the schedule of values for each purchase contract. Show line-item value of purchase contract. Indicate owner payments or deposits, if any, and balance to be paid by Contractor.
9. Each item in the schedule of values and Applications for Payment shall be complete. Include total cost and proportionate share of general overhead and profit for each item.
 - a. Temporary facilities and other major cost items that are not direct cost of actual work-in-place may be shown either as separate line items in the schedule of values or distributed as general overhead expense, at Contractor's option.
10. Schedule Updating: Update and resubmit the schedule of values before the next Applications for Payment when Change Orders or Construction Change

Directives result in a change in the Contract Sum.

1.05 APPLICATIONS FOR PAYMENT

- A. Each Application for Payment following the initial Application for Payment shall be consistent with previous applications and payments as certified by Architect and paid for by Owner.
 - 1. Initial Application for Payment, Application for Payment at time of Substantial Completion, and final Application for Payment involve additional requirements.
- B. Payment Application Times: The date for each progress payment is indicated in the Agreement between Owner and Contractor. The period of construction work covered by each Application for Payment is the period indicated in the Agreement.
 - 1. Submit draft copy of Application for Payment seven days prior to due date for review by Architect.
- C. Application for Payment Forms: Use forms acceptable to Architect and Owner for Applications for Payment. Submit forms for approval with initial submittal of schedule of values.
- D. Application Preparation: Complete every entry on form. Notarize and execute by a person authorized to sign legal documents on behalf of Contractor. Architect will return incomplete applications without action.
 - 1. Entries shall match data on the schedule of values and Contractor's construction schedule. Use updated schedules if revisions were made.
 - 2. Include amounts for work completed following previous Application for Payment, whether or not payment has been received. Include only amounts for work completed at time of Application for Payment.
 - 3. Include amounts of Change Orders and Construction Change Directives issued before last day of construction period covered by application.
 - 4. Indicate separate amounts for work being carried out under Owner-requested project acceleration.
- E. Stored Materials: Include in Application for Payment amounts applied for materials or equipment purchased or fabricated and stored, but not yet installed. Differentiate between items stored on-site and items stored off-site.
 - 1. Provide certificate of insurance, evidence of transfer of title to Owner, and consent of surety to payment, for stored materials.
 - 2. Provide supporting documentation that verifies amount requested, such as paid invoices. Match amount requested with amounts indicated on documentation; do not include overhead and profit on stored materials.
 - 3. Provide summary documentation for stored materials indicating the following:
 - a. Value of materials previously stored and remaining stored as of date of previous Applications for Payment.
 - b. Value of previously stored materials put in place after date of previous Application for Payment and on or before date of current Application for Payment.
 - c. Value of materials stored since date of previous Application for Payment and remaining stored as of date of current Application for Payment.
- F. Transmittal: Submit three signed and notarized original copies of each Application for Payment to Architect by a method ensuring receipt within 24 hours. One copy shall include waivers of lien and similar attachments if required.

1. Transmit each copy with a transmittal form listing attachments and recording appropriate information about application.
- G. Waivers of Mechanic's Lien: With each Application for Payment, submit waivers of mechanic's lien from entities lawfully entitled to file a mechanic's lien arising out of the Contract and related to the Work covered by the payment.
1. Submit partial waivers on each item for amount requested in previous application, after deduction for retainage, on each item.
 2. When an application shows completion of an item, submit conditional final or full waivers.
 3. Owner reserves the right to designate which entities involved in the Work must submit waivers.
 4. Waiver Forms: Submit executed waivers of lien on forms acceptable to Owner.
- H. Initial Application for Payment: Administrative actions and submittals that must precede or coincide with submittal of first Application for Payment include the following:
1. List of subcontractors.
 2. Schedule of values.
 3. LEED submittal for project materials cost data.
 4. Contractor's construction schedule (preliminary if not final).
 5. Combined Contractor's construction schedule (preliminary if not final) incorporating Work of multiple contracts, with indication of acceptance of schedule by each Contractor.
 6. Products list (preliminary if not final).
 7. LEED action plans.
 8. Schedule of unit prices.
 9. Submittal schedule (preliminary if not final).
 10. List of Contractor's staff assignments.
 11. List of Contractor's principal consultants.
 12. Copies of building permits.
 13. Copies of authorizations and licenses from authorities having jurisdiction for performance of the Work.
 14. Initial progress report.
 15. Report of preconstruction conference.
 16. Certificates of insurance and insurance policies.
 17. Performance and payment bonds.
 18. Data needed to acquire Owner's insurance.
- I. Application for Payment at Substantial Completion: After Architect issues the Certificate of Substantial Completion, submit an Application for Payment showing 100 percent completion for portion of the Work claimed as substantially complete.
1. Include documentation supporting claim that the Work is substantially complete and a statement showing an accounting of changes to the Contract Sum.
 2. This application shall reflect Certificate(s) of Substantial Completion issued previously for Owner occupancy of designated portions of the Work.
- J. Final Payment Application: After completing Project closeout requirements, submit final Application for Payment with releases and supporting documentation not previously submitted and accepted, including, but not limited to, the following:
1. Evidence of completion of Project closeout requirements.
 2. Insurance certificates for products and completed operations where required and proof that taxes, fees, and similar obligations were paid.

3. Updated final statement, accounting for final changes to the Contract Sum.
4. Evidence that claims have been settled.
5. Final meter readings for utilities, a measured record of stored fuel, and similar data as of date of Substantial Completion or when Owner took possession of and assumed responsibility for corresponding elements of the Work.
6. Final liquidated damages settlement statement.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 29 00

SECTION 01 31 00**PROJECT MANAGEMENT AND COORDINATION****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section includes administrative provisions for coordinating construction operations on Project including, but not limited to, the following:
 - 1. General coordination procedures.
 - 2. Coordination drawings.
 - 3. Requests for Information (RFIs).
 - 4. Project Web site.
 - 5. Project meetings.
- B. Each contractor shall participate in coordination requirements. Certain areas of responsibility are assigned to a specific contractor.
- C. Related Requirements:
 - 1. Section 01 32 00 "Construction Progress Documentation" for preparing and submitting Contractor's construction schedule.
 - 2. Section 01 73 00 "Execution" for procedures for coordinating general installation and field-engineering services, including establishment of benchmarks and control points.
 - 3. Section 01 77 00 "Closeout Procedures" for coordinating closeout of the Contract.
 - 4. Section 01 91 13 "General Commissioning Requirements" for coordinating the Work with Owner's Commissioning Authority.

1.03 DEFINITIONS

- A. RFI: Request from Owner, Architect, or Contractor seeking information required by or clarifications of the Contract Documents.

1.04 INFORMATIONAL SUBMITTALS

- A. Subcontract List: Prepare a written summary identifying individuals or firms proposed for each portion of the Work, including those who are to furnish products or equipment fabricated to a special design. Include the following information in tabular form:
 - 1. Name, address, and telephone number of entity performing subcontract or supplying products.
 - 2. Number and title of related Specification Section(s) covered by subcontract.
 - 3. Drawing number and detail references, as appropriate, covered by subcontract.
- B. Key Personnel Names: Within 15 days of starting construction operations, submit a list of key personnel assignments, including superintendent and other personnel in

attendance at Project site. Identify individuals and their duties and responsibilities; list addresses and telephone numbers, including home, office, and cellular telephone numbers and e-mail addresses. Provide names, addresses, and telephone numbers of individuals assigned as alternates in the absence of individuals assigned to Project.

1. Post copies of list in project meeting room, in temporary field office, on Project Web site, and by each temporary telephone. Keep list current at all times.

1.05 GENERAL COORDINATION PROCEDURES

- A. Coordination: Coordinate construction operations included in different Sections of the Specifications to ensure efficient and orderly installation of each part of the Work. Coordinate construction operations, included in different Sections, that depend on each other for proper installation, connection, and operation.
 1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
 2. Coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair.
 3. Make adequate provisions to accommodate items scheduled for later installation.
- B. Prepare memoranda for distribution to each party involved, outlining special procedures required for coordination. Include such items as required notices, reports, and list of attendees at meetings.
 1. Prepare similar memoranda for Owner and separate contractors if coordination of their Work is required.
- C. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities to avoid conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:
 1. Preparation of Contractor's construction schedule.
 2. Preparation of the schedule of values.
 3. Installation and removal of temporary facilities and controls.
 4. Delivery and processing of submittals.
 5. Progress meetings.
 6. Preinstallation conferences.
 7. Project closeout activities.
 8. Startup and adjustment of systems.
- D. Conservation: Coordinate construction activities to ensure that operations are carried out with consideration given to conservation of energy, water, and materials. Coordinate use of temporary utilities to minimize waste.
 1. Salvage materials and equipment involved in performance of, but not actually incorporated into, the Work. See other Sections for disposition of salvaged materials that are designated as Owner's property.

1.06 COORDINATION DRAWINGS

- A. Coordination Drawings, General: Prepare coordination drawings according to requirements in individual Sections, and additionally where installation is not completely shown on Shop Drawings, where limited space availability necessitates coordination, or if coordination is required to facilitate integration of products and

materials fabricated or installed by more than one entity.

1. Content: Project-specific information, drawn accurately to a scale large enough to indicate and resolve conflicts. Do not base coordination drawings on standard printed data. Include the following information, as applicable:
 - a. Use applicable Drawings as a basis for preparation of coordination drawings. Prepare sections, elevations, and details as needed to describe relationship of various systems and components.
 - b. Coordinate the addition of trade-specific information to the coordination drawings by multiple contractors in a sequence that best provides for coordination of the information and resolution of conflicts between installed components before submitting for review.
 - c. Indicate functional and spatial relationships of components of architectural, structural, civil, mechanical, and electrical systems.
 - d. Indicate space requirements for routine maintenance and for anticipated replacement of components during the life of the installation.
 - e. Show location and size of access doors required for access to concealed dampers, valves, and other controls.
 - f. Indicate required installation sequences.
 - g. Indicate dimensions shown on the Drawings. Specifically note dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternate sketches to Architect indicating proposed resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.

B. Coordination Drawing Organization: Organize coordination drawings as follows:

1. Floor Plans and Reflected Ceiling Plans: Show architectural and structural elements, and mechanical, plumbing, fire-protection, fire-alarm, and electrical Work. Show locations of visible ceiling-mounted devices relative to acoustical ceiling grid. Supplement plan drawings with section drawings where required to adequately represent the Work.
2. Plenum Space: Indicate subframing for support of ceiling and wall systems, mechanical and electrical equipment, and related Work. Locate components within ceiling plenum to accommodate layout of light fixtures indicated on Drawings. Indicate areas of conflict between light fixtures and other components.
3. Mechanical Rooms: Provide coordination drawings for mechanical rooms showing plans and elevations of mechanical, plumbing, fire-protection, fire-alarm, and electrical equipment.
4. Structural Penetrations: Indicate penetrations and openings required for all disciplines.
5. Slab Edge and Embedded Items: Indicate slab edge locations and sizes and locations of embedded items for metal fabrications, sleeves, anchor bolts, bearing plates, angles, door floor closers, slab depressions for floor finishes, curbs and housekeeping pads, and similar items.
6. Mechanical and Plumbing Work: Show the following:
 - a. Sizes and bottom elevations of ductwork, piping, and conduit runs, including insulation, bracing, flanges, and support systems.
 - b. Dimensions of major components, such as dampers, valves, diffusers, access doors, cleanouts and electrical distribution equipment.
 - c. Fire-rated enclosures around ductwork.
7. Electrical Work: Show the following:
 - a. Runs of vertical and horizontal conduit 1-1/4 inches in diameter and larger.
 - b. Light fixture, exit light, emergency battery pack, smoke detector, and other

- fire-alarm locations.
 - c. Panel board, switch board, switchgear, transformer, busway, generator, and motor control center locations.
 - d. Location of pull boxes and junction boxes, dimensioned from column center lines.
8. Fire-Protection System: Show the following:
- a. Locations of standpipes, mains piping, branch lines, pipe drops, and sprinkler heads.
9. Review: Architect will review coordination drawings to confirm that the Work is being coordinated, but not for the details of the coordination, which are Contractor's responsibility. If Architect determines that coordination drawings are not being prepared in sufficient scope or detail, or are otherwise deficient, Architect will so inform Contractor, who shall make changes as directed and resubmit.
10. Coordination Drawing Prints: Prepare coordination drawing prints according to requirements in Section 01 33 00 "Submittal Procedures."
- C. Coordination Digital Data Files: Prepare coordination digital data files according to the following requirements:
- 1. File Preparation Format: Same digital data software program, version, and operating system as original Drawings.
 - 2. File Submittal Format: Submit or post coordination drawing files using Portable Data File (PDF) format.
 - 3. BIM File Incorporation: Develop and incorporate coordination drawing files into Building Information Model established for Project.
 - a. Perform three-dimensional component conflict analysis as part of preparation of coordination drawings. Resolve component conflicts prior to submittal. Indicate where conflict resolution requires modification of design requirements by Architect.
 - 4. Architect will furnish Contractor one set of digital data files of Drawings for use in preparing coordination digital data files.
 - a. Architect makes no representations as to the accuracy or completeness of digital data files as they relate to Drawings.
 - b. Digital Data Software Program: Drawings are available in Insert name and version of digital data software program and operating system.
 - c. Contractor shall execute a data licensing agreement in the form of Agreement form acceptable to Owner and Architect.

1.07 REQUESTS FOR INFORMATION (RFIs)

- A. General: Immediately on discovery of the need for additional information or interpretation of the Contract Documents, Contractor shall prepare and submit an RFI in the form specified.
- 1. Architect will return RFIs submitted to Architect by other entities controlled by Contractor with no response.
 - 2. Coordinate and submit RFIs in a prompt manner so as to avoid delays in Contractor's work or work of subcontractors.
- B. Content of the RFI: Include a detailed, legible description of item needing information or interpretation and the following:

1. Project name.
 2. Project number.
 3. Date.
 4. Name of Contractor.
 5. Name of Architect.
 6. RFI number, numbered sequentially.
 7. RFI subject.
 8. Specification Section number and title and related paragraphs, as appropriate.
 9. Drawing number and detail references, as appropriate.
 10. Field dimensions and conditions, as appropriate.
 11. Contractor's suggested resolution. If Contractor's suggested resolution impacts the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.
 12. Contractor's signature.
 13. Attachments: Include sketches, descriptions, measurements, photos, Product Data, Shop Drawings, coordination drawings, and other information necessary to fully describe items needing interpretation.
 - a. Include dimensions, thicknesses, structural grid references, and details of affected materials, assemblies, and attachments on attached sketches.
- C. RFI Forms: Software-generated form with substantially the same content as indicated above, acceptable to Architect.
1. Attachments shall be electronic files in Adobe Acrobat PDF format.
- D. Architect's Action: Architect will review each RFI, determine action required, and respond. Allow seven working days for Architect's response for each RFI. RFIs received by Architect after 1:00 p.m. will be considered as received the following working day.
1. The following Contractor-generated RFIs will be returned without action:
 - a. Requests for approval of submittals.
 - b. Requests for approval of substitutions.
 - c. Requests for approval of Contractor's means and methods.
 - d. Requests for coordination information already indicated in the Contract Documents.
 - e. Requests for adjustments in the Contract Time or the Contract Sum.
 - f. Requests for interpretation of Architect's actions on submittals.
 - g. Incomplete RFIs or inaccurately prepared RFIs.
 2. Architect's action may include a request for additional information, in which case Architect's time for response will date from time of receipt of additional information.
 3. Architect's action on RFIs that may result in a change to the Contract Time or the Contract Sum may be eligible for Contractor to submit Change Proposal according to Section 01 26 00 "Contract Modification Procedures."
 - a. If Contractor believes the RFI response warrants change in the Contract Time or the Contract Sum, notify Architect in writing within 10 days of receipt of the RFI response.
- E. RFI Log: Prepare, maintain, and submit a tabular log of RFIs organized by the RFI number. Submit log weekly. Use software log that is part of Project Web site. Include the following:
1. Project name.

2. Name and address of Contractor.
 3. Name and address of Architect.
 4. RFI number including RFIs that were returned without action or withdrawn.
 5. RFI description.
 6. Date the RFI was submitted.
 7. Date Architect's response was received.
- F. On receipt of Architect's action, update the RFI log and immediately distribute the RFI response to affected parties. Review response and notify Architect within seven days if Contractor disagrees with response.
1. Identification of related Minor Change in the Work, Construction Change Directive, and Proposal Request, as appropriate.
 2. Identification of related Field Order, Work Change Directive, and Proposal Request, as appropriate.

1.08 PROJECT WEB SITE

- A. Use Owner's Project Web site for purposes of hosting and managing project communication and documentation until Final Completion. Project Web site shall include the following functions:
1. Project directory.
 2. Project correspondence.
 3. Meeting minutes.
 4. Contract modifications forms and logs.
 5. RFI forms and logs.
 6. Task and issue management.
 7. Photo documentation.
 8. Schedule and calendar management.
 9. Submittals forms and logs.
 10. Payment application forms.
 11. Drawing and specification document hosting, viewing, and updating.
 12. Online document collaboration.
 13. Reminder and tracking functions.
 14. Archiving functions.
- B. Contractor, subcontractors, and other parties granted access by Contractor to Project Web site shall execute a data licensing agreement in the form of Agreement acceptable to Owner and Architect.

1.09 PROJECT MEETINGS

- A. General: Schedule and conduct meetings and conferences at Project site unless otherwise indicated.
1. Attendees: Inform participants and others involved, and individuals whose presence is required, of date and time of each meeting. Notify Owner and Architect of scheduled meeting dates and times.
 2. Agenda: Prepare the meeting agenda. Distribute the agenda to all invited attendees.
 3. Minutes: Entity responsible for conducting meeting will record significant discussions and agreements achieved. Distribute the meeting minutes to everyone concerned, including Owner and Architect, within three days of the meeting.
- B. Preconstruction Conference: Architect will schedule and conduct a preconstruction conference before starting construction, at a time convenient to Owner and Architect,

but no later than 15 days after execution of the Agreement.

1. Conduct the conference to review responsibilities and personnel assignments.
 2. Attendees: Authorized representatives of Owner, Owner's Commissioning Authority, Architect, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the conference. Participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
 3. Agenda: Discuss items of significance that could affect progress, including the following:
 - a. Tentative construction schedule.
 - b. Phasing.
 - c. Critical work sequencing and long-lead items.
 - d. Designation of key personnel and their duties.
 - e. Lines of communications.
 - f. Procedures for processing field decisions and Change Orders.
 - g. Procedures for RFIs.
 - h. Procedures for testing and inspecting.
 - i. Procedures for processing Applications for Payment.
 - j. Distribution of the Contract Documents.
 - k. Submittal procedures.
 - l. Sustainable design requirements.
 - m. Preparation of record documents.
 - n. Use of the premises and existing building.
 - o. Work restrictions.
 - p. Working hours.
 - q. Owner's occupancy requirements.
 - r. Responsibility for temporary facilities and controls.
 - s. Procedures for moisture and mold control.
 - t. Procedures for disruptions and shutdowns.
 - u. Construction waste management and recycling.
 - v. Parking availability.
 - w. Office, work, and storage areas.
 - x. Equipment deliveries and priorities.
 - y. First aid.
 - z. Security.
 - aa. Progress cleaning.
 4. Minutes: Entity responsible for conducting meeting will record and distribute meeting minutes.
- C. LEED Coordination Conference: Owner will schedule and conduct a LEED coordination conference before starting construction, at a time convenient to Owner, Architect, and Contractor.
1. Attendees: Authorized representatives of Owner, Owner's Commissioning Authority, Architect, and their consultants; Contractor and its superintendent and LEED coordinator; major subcontractors; suppliers; and other concerned parties shall attend the conference. Participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
 2. Agenda: Discuss items of significance that could affect meeting requirements for LEED certification, including the following:
 - a. LEED Project Checklist.
 - b. General requirements for LEED-related procurement and documentation.
 - c. Project closeout requirements and LEED certification procedures.
 - d. Role of LEED coordinator.

- e. Construction waste management.
 - f. Construction operations and LEED requirements and restrictions.
3. Minutes: Entity responsible for conducting meeting will record and distribute meeting minutes.
- D. Preinstallation Conferences: Conduct a preinstallation conference at Project site before each construction activity that requires coordination with other construction.
1. Attendees: Installer and representatives of manufacturers and fabricators involved in or affected by the installation and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advise Architect and Owner's Commissioning Authority of scheduled meeting dates.
 2. Agenda: Review progress of other construction activities and preparations for the particular activity under consideration, including requirements for the following:
 - a. Contract Documents.
 - b. Options.
 - c. Related RFIs.
 - d. Related Change Orders.
 - e. Purchases.
 - f. Deliveries.
 - g. Submittals.
 - h. LEED requirements.
 - i. Review of mockups.
 - j. Possible conflicts.
 - k. Compatibility requirements.
 - l. Time schedules.
 - m. Weather limitations.
 - n. Manufacturer's written instructions.
 - o. Warranty requirements.
 - p. Compatibility of materials.
 - q. Acceptability of substrates.
 - r. Temporary facilities and controls.
 - s. Space and access limitations.
 - t. Regulations of authorities having jurisdiction.
 - u. Testing and inspecting requirements.
 - v. Installation procedures.
 - w. Coordination with other work.
 - x. Required performance results.
 - y. Protection of adjacent work.
 - z. Protection of construction and personnel.
 3. Record significant conference discussions, agreements, and disagreements, including required corrective measures and actions.
 4. Reporting: Distribute minutes of the meeting to each party present and to other parties requiring information.
 5. Do not proceed with installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of the Work and reconvene the conference at earliest feasible date.
- E. Project Closeout Conference: Schedule and conduct a project closeout conference, at a time convenient to Owner and Architect, but no later than 90 days prior to the scheduled date of Substantial Completion.
1. Conduct the conference to review requirements and responsibilities related to

- Project closeout.
2. Attendees: Authorized representatives of Owner, Owner's Commissioning Authority, Architect, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the meeting. Participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.
 3. Agenda: Discuss items of significance that could affect or delay Project closeout, including the following:
 - a. Preparation of record documents.
 - b. Procedures required prior to inspection for Substantial Completion and for final inspection for acceptance.
 - c. Submittal of written warranties.
 - d. Requirements for completing LEED documentation.
 - e. Requirements for preparing operations and maintenance data.
 - f. Requirements for delivery of material samples, attic stock, and spare parts.
 - g. Requirements for demonstration and training.
 - h. Preparation of Contractor's punch list.
 - i. Procedures for processing Applications for Payment at Substantial Completion and for final payment.
 - j. Submittal procedures.
 - k. Coordination of separate contracts.
 - l. Owner's partial occupancy requirements.
 - m. Installation of Owner's furniture, fixtures, and equipment.
 - n. Responsibility for removing temporary facilities and controls.
 4. Minutes: Entity conducting meeting will record and distribute meeting minutes.
- F. Progress Meetings: Conduct progress meetings at weekly intervals.
1. Coordinate dates of meetings with preparation of payment requests.
 2. Attendees: In addition to representatives of Owner, Owner's Commissioning Authority and Architect, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.
 3. Agenda: Review and correct or approve minutes of previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.
 - a. Contractor's Construction Schedule: Review progress since the last meeting. Determine whether each activity is on time, ahead of schedule, or behind schedule, in relation to Contractor's construction schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.
 - 1) Review schedule for next period.
 - b. Review present and future needs of each entity present, including the following:
 - 1) Interface requirements.
 - 2) Sequence of operations.
 - 3) Resolution of BIM component conflicts.
 - 4) Status of submittals.

- 5) Status of LEED documentation.
 - 6) Deliveries.
 - 7) Off-site fabrication.
 - 8) Access.
 - 9) Site utilization.
 - 10) Temporary facilities and controls.
 - 11) Progress cleaning.
 - 12) Quality and work standards.
 - 13) Status of correction of deficient items.
 - 14) Field observations.
 - 15) Status of RFIs.
 - 16) Status of proposal requests.
 - 17) Pending changes.
 - 18) Status of Change Orders.
 - 19) Pending claims and disputes.
 - 20) Documentation of information for payment requests.
4. Minutes: Entity responsible for conducting the meeting will record and distribute the meeting minutes to each party present and to parties requiring information.
 - a. Schedule Updating: Revise Contractor's construction schedule after each progress meeting where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with the report of each meeting.
- G. Coordination Meetings: Conduct Project coordination meetings at weekly intervals. Project coordination meetings are in addition to specific meetings held for other purposes, such as progress meetings and preinstallation conferences.
1. Attendees: In addition to representatives of Owner, Owner's Commissioning Authority and Architect, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the meetings shall be familiar with Project and authorized to conclude matters relating to the Work.
 2. Agenda: Review and correct or approve minutes of the previous coordination meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.
 - a. Combined Contractor's Construction Schedule: Review progress since the last coordination meeting. Determine whether each contract is on time, ahead of schedule, or behind schedule, in relation to combined Contractor's construction schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.
 - b. Schedule Updating: Revise combined Contractor's construction schedule after each coordination meeting where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with report of each meeting.
 - c. Review present and future needs of each contractor present, including the following:
 - 1) Interface requirements.
 - 2) Sequence of operations.
 - 3) Resolution of BIM component conflicts.
 - 4) Status of submittals.
 - 5) Deliveries.

- 6) Off-site fabrication.
 - 7) Access.
 - 8) Site utilization.
 - 9) Temporary facilities and controls.
 - 10) Work hours.
 - 11) Hazards and risks.
 - 12) Progress cleaning.
 - 13) Quality and work standards.
 - 14) Change Orders.
3. Reporting: Record meeting results and distribute copies to everyone in attendance and to others affected by decisions or actions resulting from each meeting.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 31 00

SECTION 01 32 00**CONSTRUCTION PROGRESS DOCUMENTATION****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section includes administrative and procedural requirements for documenting the progress of construction during performance of the Work, including the following:
1. Startup construction schedule.
 2. Contractor's construction schedule.
 3. Construction schedule updating reports.
 4. Daily construction reports.
 5. Material location reports.
 6. Site condition reports.
 7. Special reports.
 8. LEED log binder.
- B. Related Requirements:
1. Section 01 33 00 "Submittal Procedures" for submitting schedules and reports.
 2. Section 01 40 00 "Quality Requirements" for submitting a schedule of tests and inspections.

1.03 DEFINITIONS

- A. Activity: A discrete part of a project that can be identified for planning, scheduling, monitoring, and controlling the construction project. Activities included in a construction schedule consume time and resources.
1. Critical Activity: An activity on the critical path that must start and finish on the planned early start and finish times.
 2. Predecessor Activity: An activity that precedes another activity in the network.
 3. Successor Activity: An activity that follows another activity in the network.
- B. Cost Loading: The allocation of the schedule of values for the completion of an activity as scheduled. The sum of costs for all activities must equal the total Contract Sum unless otherwise approved by Architect.
- C. CPM: Critical path method, which is a method of planning and scheduling a construction project where activities are arranged based on activity relationships. Network calculations determine when activities can be performed and the critical path of Project.
- D. Critical Path: The longest connected chain of interdependent activities through the network schedule that establishes the minimum overall Project duration and contains no float.
- E. Event: The starting or ending point of an activity.

- F. Float: The measure of leeway in starting and completing an activity.
1. Float time is not for the exclusive use or benefit of either Owner or Contractor, but is a jointly owned, expiring Project resource available to both parties as needed to meet schedule milestones and Contract completion date.
 2. Free float is the amount of time an activity can be delayed without adversely affecting the early start of the successor activity.
 3. Total float is the measure of leeway in starting or completing an activity without adversely affecting the planned Project completion date.
- G. Resource Loading: The allocation of manpower and equipment necessary for the completion of an activity as scheduled.

1.04 INFORMATIONAL SUBMITTALS

- A. Format for Submittals: Submit required submittals in the following formats:
1. Working electronic copy of schedule file, where indicated.
 2. PDF electronic file.
- B. Startup construction schedule.
1. Approval of cost-loaded, startup construction schedule will not constitute approval of schedule of values for cost-loaded activities.
- C. Startup Network Diagram: Of size required to display entire network for entire construction period. Show logic ties for activities.
- D. Contractor's Construction Schedule: Initial schedule, of size required to display entire schedule for entire construction period.
1. Submit a working electronic copy of schedule, using software indicated, and labeled to comply with requirements for submittals. Include type of schedule (initial or updated) and date on label.
- E. CPM Reports: Concurrent with CPM schedule, submit each of the following reports. Format for each activity in reports shall contain activity number, activity description, cost and resource loading, original duration, remaining duration, early start date, early finish date, late start date, late finish date, and total float in calendar days.
1. Activity Report: List of all activities sorted by activity number and then early start date, or actual start date if known.
 2. Logic Report: List of preceding and succeeding activities for all activities, sorted in ascending order by activity number and then early start date, or actual start date if known.
 3. Total Float Report: List of all activities sorted in ascending order of total float.
 4. Earnings Report: Compilation of Contractor's total earnings from the Notice to Proceed until most recent Application for Payment.
- F. Construction Schedule Updating Reports: Submit with Applications for Payment.
- G. Daily Construction Reports: Submit at weekly intervals.
- H. Material Location Reports: Submit at weekly intervals.
- I. Site Condition Reports: Submit at time of discovery of differing conditions.
- J. Special Reports: Submit at time of unusual event.

- K. Qualification Data: For scheduling consultant.
- L. LEED Log Binder, containing completed material tracking spreadsheets.

1.05 QUALITY ASSURANCE

- A. Scheduling Consultant Qualifications: An experienced specialist in CPM scheduling and reporting, with capability of producing CPM reports and diagrams within 24 hours of Architect's request.
- B. Prescheduling Conference: Conduct conference at Project site to comply with requirements in Section 01 31 00 "Project Management and Coordination." Review methods and procedures related to the preliminary construction schedule and Contractor's construction schedule, including, but not limited to, the following:
 - 1. Review software limitations and content and format for reports.
 - 2. Verify availability of qualified personnel needed to develop and update schedule.
 - 3. Discuss constraints, including work stages, interim milestones and partial Owner occupancy.
 - 4. Review delivery dates for Owner-furnished products.
 - 5. Review schedule for work of Owner's separate contracts.
 - 6. Review submittal requirements and procedures.
 - 7. Review time required for review of submittals and resubmittals.
 - 8. Review requirements for tests and inspections by independent testing and inspecting agencies.
 - 9. Review time required for Project closeout and Owner startup procedures, including commissioning activities.
 - 10. Review and finalize list of construction activities to be included in schedule.
 - 11. Review procedures for updating schedule.

1.06 COORDINATION

- A. Coordinate Contractor's construction schedule with the schedule of values, list of subcontracts, submittal schedule, progress reports, payment requests, and other required schedules and reports.
 - 1. Secure time commitments for performing critical elements of the Work from entities involved.
 - 2. Coordinate each construction activity in the network with other activities and schedule them in proper sequence.

PART 2 - PRODUCTS

2.01 CONTRACTOR'S CONSTRUCTION SCHEDULE, GENERAL

- A. Time Frame: Extend schedule from date established for the Notice to Proceed to date of Substantial Completion.
 - 1. Contract completion date shall not be changed by submission of a schedule that shows an early completion date, unless specifically authorized by Change Order.
- B. Activities: Treat each story or separate area as a separate numbered activity for each main element of the Work. Comply with the following:
 - 1. Activity Duration: Define activities so no activity is longer than 20 days, unless specifically allowed by Architect.

2. Procurement Activities: Include procurement process activities for the following long lead items and major items, requiring a cycle of more than 60 days, as separate activities in schedule. Procurement cycle activities include, but are not limited to, submittals, approvals, purchasing, fabrication, and delivery.
 3. Submittal Review Time: Include review and resubmittal times indicated in Section 01 33 00 "Submittal Procedures" in schedule. Coordinate submittal review times in Contractor's construction schedule with submittal schedule.
 4. Startup and Testing Time: Include no fewer than 15 days for startup and testing.
 5. Substantial Completion: Indicate completion in advance of date established for Substantial Completion, and allow time for Architect's administrative procedures necessary for certification of Substantial Completion.
 6. Punch List and Final Acceptance: Include not more than 30 days for completion of punch list items and final completion.
- C. Constraints: Include constraints and work restrictions indicated in the Contract Documents and as follows in schedule, and show how the sequence of the Work is affected.
1. Work under More Than One Contract: Include a separate activity for each contract.
 2. Work by Owner: Include a separate activity for each portion of the Work performed by Owner.
 3. Products Ordered in Advance: Include a separate activity for each product. Include delivery date indicated in Section 01 10 00 "Summary." Delivery dates indicated stipulate the earliest possible delivery date.
 4. Owner-Furnished Products: Include a separate activity for each product. Include delivery date indicated in Section 01 10 00 "Summary." Delivery dates indicated stipulate the earliest possible delivery date.
 5. Work Restrictions: Show the effect of the following items on the schedule:
 - a. Coordination with existing construction.
 - b. Uninterruptible services.
 - c. Partial occupancy before Substantial Completion.
 - d. Use of premises restrictions.
 - e. Provisions for future construction.
 - f. Seasonal variations.
 - g. Environmental control.
 6. Work Stages: Indicate important stages of construction for each major portion of the Work, including, but not limited to, the following:
 - a. Subcontract awards.
 - b. Submittals.
 - c. Purchases.
 - d. Mockups.
 - e. Fabrication.
 - f. Sample testing.
 - g. Deliveries.
 - h. Installation.
 - i. Tests and inspections.
 - j. Adjusting.
 - k. Curing.
 - l. Building flush-out.
 - m. Startup and placement into final use and operation.
 7. Construction Areas: Identify each major area of construction for each major portion of the Work. Indicate where each construction activity within a major area must be sequenced or integrated with other construction activities to provide for

the following:

- a. Structural completion.
 - b. Temporary enclosure and space conditioning.
 - c. Permanent space enclosure.
 - d. Completion of mechanical installation.
 - e. Completion of electrical installation.
 - f. Substantial Completion.
8. Milestones: Include milestones indicated in the Contract Documents in schedule, including, but not limited to, the Notice to Proceed, Substantial Completion, and final completion.
- D. Cost Correlation: Superimpose a cost correlation timeline, indicating planned and actual costs. On the line, show planned and actual dollar volume of the Work performed as of planned and actual dates used for preparation of payment requests.
1. See Section 01 29 00 "Payment Procedures" for cost reporting and payment procedures.
- E. Upcoming Work Summary: Prepare summary report indicating activities scheduled to occur or commence prior to submittal of next schedule update. Summarize the following issues:
1. Unresolved issues.
 2. Unanswered Requests for Information.
 3. Rejected or unreturned submittals.
 4. Notations on returned submittals.
 5. Pending modifications affecting the Work and Contract Time.
- F. Recovery Schedule: When periodic update indicates the Work is 14 or more calendar days behind the current approved schedule, submit a separate recovery schedule indicating means by which Contractor intends to regain compliance with the schedule. Indicate changes to working hours, working days, crew sizes, and equipment required to achieve compliance, and date by which recovery will be accomplished.
- G. Computer Scheduling Software: Prepare schedules using current version of a program that has been developed specifically to manage construction schedules.

2.02 STARTUP CONSTRUCTION SCHEDULE

- A. Bar-Chart Schedule: Submit startup, horizontal, bar-chart-type construction schedule within seven days of date established for the Notice of Award.
- B. Preparation: Indicate each significant construction activity separately. Identify first workday of each week with a continuous vertical line. Outline significant construction activities for first 45 days of construction. Include skeleton diagram for the remainder of the Work and a cash requirement prediction based on indicated activities.

2.03 CONTRACTOR'S CONSTRUCTION SCHEDULE (CPM SCHEDULE)

- A. General: Prepare network diagrams using AON (activity-on-node) format.
- B. Startup Network Diagram: Submit diagram within 14 days of date established for the Notice to Proceed. Outline significant construction activities for the first 45 days of construction. Include skeleton diagram for the remainder of the Work and a cash requirement prediction based on indicated activities.

- C. CPM Schedule: Prepare Contractor's construction schedule using a cost- and resource-loaded, time-scaled CPM network analysis diagram for the Work.
1. Develop network diagram in sufficient time to submit CPM schedule so it can be accepted for use no later than 60 days after date established for the Notice to Proceed.
 - a. Failure to include any work item required for performance of this Contract shall not excuse Contractor from completing all work within applicable completion dates, regardless of Architect's approval of the schedule.
 2. Conduct educational workshops to train and inform key Project personnel, including subcontractors' personnel, in proper methods of providing data and using CPM schedule information.
 3. Establish procedures for monitoring and updating CPM schedule and for reporting progress. Coordinate procedures with progress meeting and payment request dates.
 4. Use "one workday" as the unit of time for individual activities. Indicate nonworking days and holidays incorporated into the schedule in order to coordinate with the Contract Time.
- D. CPM Schedule Preparation: Prepare a list of all activities required to complete the Work. Using the startup network diagram, prepare a skeleton network to identify probable critical paths.
1. Activities: Indicate the estimated time duration, sequence requirements, and relationship of each activity in relation to other activities. Include estimated time frames for the following activities:
 - a. Preparation and processing of submittals.
 - b. Mobilization and demobilization.
 - c. Purchase of materials.
 - d. Delivery.
 - e. Fabrication.
 - f. Utility interruptions.
 - g. Installation.
 - h. Work by Owner that may affect or be affected by Contractor's activities.
 - i. Testing and commissioning.
 - j. Punch list and final completion.
 - k. Activities occurring following final completion.
 2. Critical Path Activities: Identify critical path activities, including those for interim completion dates. Scheduled start and completion dates shall be consistent with Contract milestone dates.
 3. Processing: Process data to produce output data on a computer-drawn, time-scaled network. Revise data, reorganize activity sequences, and reproduce as often as necessary to produce the CPM schedule within the limitations of the Contract Time.
 4. Format: Mark the critical path. Locate the critical path near center of network; locate paths with most float near the edges.
 - a. Subnetworks on separate sheets are permissible for activities clearly off the critical path.
 5. Cost- and Resource-Loading of CPM Schedule: Assign cost to construction activities on the CPM schedule. Do not assign costs to submittal activities. Obtain Architect's approval prior to assigning costs to fabrication and delivery activities. Assign costs under main subcontracts for testing and commissioning

activities, operation and maintenance manuals, punch list activities, Project record documents, LEED documentation, and demonstration and training (if applicable), in the amount of 5 percent of the Contract Sum.

- a. Each activity cost shall reflect an appropriate value subject to approval by Architect.
 - b. Total cost assigned to activities shall equal the total Contract Sum.
- E. Contract Modifications: For each proposed contract modification and concurrent with its submission, prepare a time-impact analysis using a network fragment to demonstrate the effect of the proposed change on the overall project schedule.
- F. Initial Issue of Schedule: Prepare initial network diagram from a sorted activity list indicating straight "early start-total float." Identify critical activities. Prepare tabulated reports showing the following:
1. Contractor or subcontractor and the Work or activity.
 2. Description of activity.
 3. Main events of activity.
 4. Immediate preceding and succeeding activities.
 5. Early and late start dates.
 6. Early and late finish dates.
 7. Activity duration in workdays.
 8. Total float or slack time.
 9. Average size of workforce.
 10. Dollar value of activity (coordinated with the schedule of values).
- G. Schedule Updating: Concurrent with making revisions to schedule, prepare tabulated reports showing the following:
1. Identification of activities that have changed.
 2. Changes in early and late start dates.
 3. Changes in early and late finish dates.
 4. Changes in activity durations in workdays.
 5. Changes in the critical path.
 6. Changes in total float or slack time.
 7. Changes in the Contract Time.
- H. Value Summaries: Prepare two cumulative value lists, sorted by finish dates.
1. In first list, tabulate activity number, early finish date, dollar value, and cumulative dollar value.
 2. In second list, tabulate activity number, late finish date, dollar value, and cumulative dollar value.
 3. In subsequent issues of both lists, substitute actual finish dates for activities completed as of list date.
 4. Prepare list for ease of comparison with payment requests; coordinate timing with progress meetings.
 - a. In both value summary lists, tabulate "actual percent complete" and "cumulative value completed" with total at bottom.
 - b. Submit value summary printouts one week before each regularly scheduled progress meeting.

2.04 REPORTS

- A. Daily Construction Reports: Prepare a daily construction report recording the following information concerning events at Project site:

1. List of subcontractors at Project site.
 2. List of separate contractors at Project site.
 3. Approximate count of personnel at Project site.
 4. Equipment at Project site.
 5. Material deliveries.
 6. High and low temperatures and general weather conditions, including presence of rain or snow.
 7. Accidents.
 8. Meetings and significant decisions.
 9. Unusual events (see special reports).
 10. Stoppages, delays, shortages, and losses.
 11. Meter readings and similar recordings.
 12. Emergency procedures.
 13. Orders and requests of authorities having jurisdiction.
 14. Change Orders received and implemented.
 15. Change Notices received and implemented.
 16. Services connected and disconnected.
 17. Equipment or system tests and startups.
 18. Partial completions and occupancies.
 19. Substantial Completions authorized.
- B. Material Location Reports: At weekly intervals, prepare and submit a comprehensive list of materials delivered to and stored at Project site. List shall be cumulative, showing materials previously reported plus items recently delivered. Include with list a statement of progress on and delivery dates for materials or items of equipment fabricated or stored away from Project site. Indicate the following categories for stored materials:
1. Material stored prior to previous report and remaining in storage.
 2. Material stored prior to previous report and since removed from storage and installed.
 3. Material stored following previous report and remaining in storage.
- C. Site Condition Reports: Immediately on discovery of a difference between site conditions and the Contract Documents, prepare and submit a detailed report. Submit with a Request for Information. Include a detailed description of the differing conditions, together with recommendations for changing the Contract Documents.

2.05 LEED LOG BINDER

- A. Maintain LEED log binder at field office.
1. Include copies of updated materials tracking spreadsheet.
 - a. Submit updated copies of materials tracking spreadsheet with Application for Payment in accordance with Section 01 29 00 - Payment Procedures.
 2. Include copies of all LEED-related information submittals required by technical specifications sections.

2.06 SPECIAL REPORTS

- A. General: Submit special reports directly to Owner within one day(s) of an occurrence. Distribute copies of report to parties affected by the occurrence.
- B. Reporting Unusual Events: When an event of an unusual and significant nature

occurs at Project site, whether or not related directly to the Work, prepare and submit a special report. List chain of events, persons participating, response by Contractor's personnel, evaluation of results or effects, and similar pertinent information. Advise Owner in advance when these events are known or predictable.

PART 3 - EXECUTION

3.01 CONTRACTOR'S CONSTRUCTION SCHEDULE

- A. Scheduling: Assign skilled personnel with experience in CPM scheduling and reporting techniques.
- B. Meetings: Scheduling personnel shall attend all meetings related to Project progress, alleged delays, and time impact.
- C. Contractor's Construction Schedule Updating: At monthly intervals, update schedule to reflect actual construction progress and activities. Issue schedule one week before each regularly scheduled progress meeting.
 - 1. Revise schedule immediately after each meeting or other activity where revisions have been recognized or made. Issue updated schedule concurrently with the report of each such meeting.
 - 2. Include a report with updated schedule that indicates every change, including, but not limited to, changes in logic, durations, actual starts and finishes, and activity durations.
 - 3. As the Work progresses, indicate final completion percentage for each activity.
- D. Distribution: Distribute copies of approved schedule to Architect, Owner, separate contractors, testing and inspecting agencies, and other parties identified by Contractor with a need-to-know schedule responsibility.
 - 1. Post copies in Project meeting rooms and temporary field offices.
 - 2. When revisions are made, distribute updated schedules to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the Work and are no longer involved in performance of construction activities.

END OF SECTION 01 32 00

SECTION 01 33 00

SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

- A. General requirements and procedures for preparing and submitting product data, shop drawings, samples, and other submittals for review and approval.

1.2 DEFINITIONS

- A. Product Data: Includes illustrations, standard schedules, diagrams, performance charts, instructions, and brochures that illustrate physical appearance, size, and other characteristics of materials and equipment for some portion of the work.
- B. Shop Drawings: Drawings, diagrams, schedules and other data specially prepared for the Work by the Contractor or a Subcontractor, Sub-subcontractor, manufacturer, supplier, or distributor to illustrate some portion of the Work.
- C. Samples: Physical examples of materials, equipment, or workmanship that illustrate functional and aesthetic characteristics of a material or product and establish standard by which the work will be judged.
- D. Day: Calendar day.

1.3 SUBMITTALS

- A. Schedule of Submittals: Within 45 Days after the effective date of Notice to Proceed, submit a completed submittal list.
 - 1. Include for each planned submittal:
 - a. Date on which each submittal will be submitted.
 - b. Contract Specifications reference, by Section and Article.
 - c. Intended submission/resubmission date(s).
 - d. Lead time to delivery/anticipated delivery date(s).
 - 2. Highlight submittals that are on the critical path and add each of these submittals as an activity on the CPM Schedule required by Section 01 32 13, Scheduling of Work.
 - 3. Update and resubmit Schedule of Submittals on a monthly basis.

1.4 CONTRACTOR'S RESPONSIBILITIES

- A. Submit in a timely manner:
1. Submit product data and samples not less than 45 days before scheduled procurement. Contractor shall be responsible for scheduling submittals such that the project schedule is not delayed.
 2. Submit shop drawings not less than 30 days before work involving such drawings is to be performed as indicated on the Contractor's CPM Schedule.
 3. Contractor shall bear the risk when products, equipment, or materials are procured before approval of submittals or work is started before approval of shop drawings.
- B. Review Submittals Before Transmitting to Engineer:
1. Stamp and sign submittals as reviewed and approved by the Contractor before submission, including subcontractor submittals.
 2. Coordinate each submittal with the requirements of the Work, placing particular emphasis upon ensuring that each submittal of one trade is compatible with other submittals of that trade and with the submittals of other trades.
 3. Submit complete with all relevant data required for review.
 4. Contractor shall be responsible for the correctness of the drawings, for shop fits and field connections, and for the results obtained by the use of such drawings.
- C. Attend meetings as requested by the Engineer to address issues related to the review of submittals.

1.5 THE ENGINEER'S REVIEW

- A. Each submittal listed in the Specifications shall be submitted for review and approval by the Engineer. The Engineer will indicate the submittal disposition as follows:
1. **NO EXCEPTIONS TAKEN** means submittal appears to conform to requirements of Contract Documents, that manufacture, fabrication, assembly, and installation of submitted product may proceed; and submittal need not be resubmitted.
 2. **EXCEPTIONS AS NOTED - RESUBMISSION NOT REQUIRED** means submittal appears to conform to requirements of Contract Documents upon incorporation of reviewer's corrections, and manufacture, fabrication, assembly, and installation of submitted product may proceed. Submittal need not be resubmitted unless Contractor challenges reviewer's exception.
 3. **EXCEPTIONS AS NOTED - RESUBMISSION REQUIRED** means submittal appears to conform to requirements of Contract Documents upon incorporation of reviewer's corrections, and manufacture, fabrication, assembly, and installation of submitted product may proceed after incorporation of reviewer's corrections and verification by Engineer that reviewer's corrections have been properly incorporated into submittal.
 - a. Resubmission is required.
 - b. Resubmit within 30 days of date of reviewer's transmittal.
 4. **REJECTED** means submittal is deficient to the degree that reviewer cannot correct submittal with a reasonable degree of effort, has not made a thorough review of submittal, and submittal needs revision and is to be corrected and resubmitted.

- B. The Engineer will transmit the disposition of the Contractor's submittal within 30 days after submittals have been received.
- C. Incomplete submittal packages will be returned without review.
- D. Include at least 30 days in the Contractor's CPM schedule for the Engineer and other parties to review submittals, unless otherwise specified.
- E. Allow 30 days for review by the Engineer of all re-submittals.
- F. The Contractor shall not be relieved from liability for form, fit, and function of any item, regardless of the Engineer's approval.

1.6 SUBMITTAL PROCEDURES

- A. Provide each submittal listed in the Submittal Article of each Specification Section.
- B. Identify submittals with the Contract Specification number (34 21 19), followed by the Specification Article number (1.03), paragraph number (B) and subparagraph numbers (2 a), followed by the review cycle number of the submittal (.001).
 - 1. Example: 34 21 19-1.03 B 2 a.001
 - 2. For subsequent resubmittals, the name and number must be identical to that of the original submittal, except that the review cycle number is incremented by 1:
 - a. First submittal: Ends in ".001"
 - b. Second submittal: Ends in ".002"
 - c. Third submittal: Ends in ".003"
- C. Submittal Medium: Provide electronic copy in pdf format with bookmarks to separate sections.
- D. Include the following information in each submittal:
 - 1. Contract title and number.
 - 2. Applicable standards, such as ASTM or IEEE.
 - 3. Identification of deviations from the Contract Drawings and Contract Specifications.
 - 4. Contractor's stamp, initialed or signed, certifying:
 - a. Dimensional compatibility of the product with the space in which it is intended to be used.
 - b. Review of submittals for compliance with the specified requirements.
 - c. Compatibility of the product with other products with which it is to perform or with which it will be contiguous.
 - 5. Professional Engineer's stamp, where required in Specifications.
- E. Attach a transmittal form to each submittal.

1.7 CHANGES

- A. Changes in Reviewed Submittals: Changes in reviewed submittals will not be permitted unless those approved submittals with changes have been resubmitted and reviewed, in the same manner as the original submittal.
- B. Changes in products for which shop drawings, product data, or samples have been submitted will not be permitted unless those changes have been accepted and approved, in writing, by the Engineer. Updated shop drawings, product data, and/or samples shall be provided to the Engineer for review and approval prior to procurement.
- C. Supplemental Submittals: Initiated by the Contractor for consideration of corrective procedures.
 - 1. Shall contain sufficient data for review.
 - 2. Make supplemental submittals in the same manner as initial submittals.

1.8 PRODUCT DATA

- A. Clearly indicate on product selection tables which product and which options are being provided.
- B. Line through or delete information that is not applicable to the Contract.

1.9 SHOP DRAWINGS

- A. Drawings shall be fully legible. Text on 22 x 34 drawings shall not be smaller than 1/8 inch and on 11 x 17 drawings shall not be smaller than 1/16 inch.
- B. Include a title block in the lower right hand corner that identifies the Contractor, Subcontractor, Contract by number and title, subject matter of the drawing, sheet number, date of the original issue of the drawing, and the serial number and date of each revision. Where required by Specification, provide an area in the title block or nearby for Professional Engineer's stamp.
- C. Submittal Stamp and Action Block Space: Include a 5-inch square blank space, in the lower right corner, just above the title block, in which the Engineer may indicate the action taken.
- D. Provide sufficient dimensions on drawings so that size and location may be determined without calculation.
- E. Sample Drawings: The first drawings submitted by Contractor will be reviewed for conformance. Once approval is given, use this approved drawing format as the standard and prepare subsequent drawings to a quality equal to the approved standard.

1.10 SAMPLES

- A. Furnish to the Engineer samples indicated in the Contract Documents or these Specifications. Submit samples without charge, with shipping charges prepaid. Materials for which samples are required shall not be used in the Work until samples are reviewed.
- B. Label each sample with the following data:
 - 1. Name, number, and location of project.
 - 2. Name of Contractor.
 - 3. Material or equipment represented, and location in the project.

4. Name of producer, brand, trade name if applicable, and place of origin.
 5. Date of submittal.
- C. Approval of a sample will be only for characteristics and use named in submittal and approval, and shall not be construed to change or modify any Contract requirement.
 - D. Test samples as required by Contract Specifications.
 - E. Samples of material from local sources shall be taken by or in the presence of the Engineer; otherwise, samples will not be considered for testing.
 - F. Failure of any material to pass specified tests will be sufficient cause for refusal to consider, under this Contract, any further samples of the same brand, make, or source of that material. The Engineer reserves the right to disapprove any material that has previously proven unsatisfactory in service.
 - G. Samples of material delivered on site or in place may be taken by the Engineer for Quality Assurance testing and will not be returned to the Contractor. Failure of samples to meet Contract requirements will annul previous approvals of item tested.

PART 2 - PRODUCTS

Not Used

PART 3 - EXECUTION

Not Used

PART 4 - MEASUREMENT AND PAYMENT**4.1 MEASUREMENT**

Not Used

4.2 PAYMENT

Not Used

END OF SECTION

SECTION 01 33 00**SUBMITTAL PROCEDURES****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section includes requirements for the submittal schedule and administrative and procedural requirements for submitting Shop Drawings, Product Data, Samples, and other submittals.
- B. Related Requirements:
 - 1. Section 01 29 00 "Payment Procedures" for submitting Applications for Payment and the schedule of values.
 - 2. Section 01 32 00 "Construction Progress Documentation" for submitting schedules and reports, including Contractor's construction schedule.
 - 3. Section 01 77 00 "Closeout Procedures" for submitting operation and maintenance manuals, record documents, and demonstration and training videos.

1.03 DEFINITIONS

- A. Action Submittals: Written and graphic information and physical samples that require Architect's responsive action. Action submittals are those submittals indicated in individual Specification Sections as "action submittals."
- B. Informational Submittals: Written and graphic information and physical samples that do not require Architect's responsive action. Submittals may be rejected for not complying with requirements. Informational submittals are those submittals indicated in individual Specification Sections as "informational submittals."
- C. File Transfer Protocol (FTP): Communications protocol that enables transfer of files to and from another computer over a network and that serves as the basis for standard Internet protocols. An FTP site is a portion of a network located outside of network firewalls within which internal and external users are able to access files.
- D. Portable Document Format (PDF): An open standard file format licensed by Adobe Systems used for representing documents in a device-independent and display resolution-independent fixed-layout document format.

1.04 ACTION SUBMITTALS

- A. Submittal Schedule: Submit a schedule of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, ordering, manufacturing, fabrication, and delivery when establishing dates. Include additional time required for making corrections or revisions to submittals noted by Architect and additional time for handling and reviewing submittals required by those corrections.
 - 1. Coordinate submittal schedule with list of subcontracts, the schedule of values,

- and Contractor's construction schedule.
2. Initial Submittal: Submit concurrently with startup construction schedule. Include submittals required during the first 60 days of construction. List those submittals required to maintain orderly progress of the Work and those required early because of long lead time for manufacture or fabrication.
 3. Final Submittal: Submit concurrently with the first complete submittal of Contractor's construction schedule.
 - a. Submit revised submittal schedule to reflect changes in current status and timing for submittals.
 4. Format: Arrange the following information in a tabular format:
 - a. Scheduled date for first submittal.
 - b. Specification Section number and title.
 - c. Submittal category: Action; informational.
 - d. Name of subcontractor.
 - e. Description of the Work covered.
 - f. Scheduled date for Architect's final release or approval.
 - g. Scheduled date of fabrication.
 - h. Scheduled dates for purchasing.
 - i. Scheduled dates for installation.
 - j. Activity or event number.

1.05 SUBMITTAL ADMINISTRATIVE REQUIREMENTS

- A. Architect's Digital Data Files: Electronic digital data files of the Contract Drawings will be provided by Architect for Contractor's use in preparing submittals.
 1. Architect will furnish Contractor one set of digital data drawing files of the Contract Drawings for use in preparing Shop Drawings.
 - a. Architect makes no representations as to the accuracy or completeness of digital data drawing files as they relate to the Contract Drawings.
 - b. Digital Drawing Software Program: The Contract Drawings are available in Insert name and version of digital drawing software program and operating system .
 - c. Contractor shall execute a data licensing agreement in the form of Agreement form acceptable to Owner and Architect.
 - d. The following digital data files will be furnished for each appropriate discipline:
 - 1) Floor plans.
 - 2) Reflected ceiling plans.
- B. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.
 1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
 2. Submit all submittal items required for each Specification Section concurrently unless partial submittals for portions of the Work are indicated on approved submittal schedule.
 3. Submit action submittals and informational submittals required by the same Specification Section as separate packages under separate transmittals.
 4. Coordinate transmittal of different types of submittals for related parts of the Work so processing will not be delayed because of need to review submittals concurrently for coordination.

- a. Architect reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.
- C. Processing Time: Allow time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Architect's receipt of submittal. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.
1. Initial Review: Allow 15 days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. Architect will advise Contractor when a submittal being processed must be delayed for coordination.
 2. Intermediate Review: If intermediate submittal is necessary, process it in same manner as initial submittal.
 3. Resubmittal Review: Allow 15 days for review of each resubmittal.
 4. Sequential Review: Where sequential review of submittals by Architect's consultants, Owner, or other parties is indicated, allow 21 days for initial review of each submittal.
 5. Concurrent Consultant Review: Where the Contract Documents indicate that submittals may be transmitted simultaneously to Architect and to Architect's consultants, allow 15 days for review of each submittal. Submittal will be returned to Architect before being returned to Contractor.
- D. Electronic Submittals: Identify and incorporate information in each electronic submittal file as follows:
1. Assemble complete submittal package into a single indexed file incorporating submittal requirements of a single Specification Section and transmittal form with links enabling navigation to each item.
 2. Name file with submittal number or other unique identifier, including revision identifier.
 - a. File name shall use project identifier and Specification Section number followed by a decimal point and then a sequential number (e.g., LSCE-061000.01). Resubmittals shall include an alphabetic suffix after another decimal point (e.g., LSCE-061000.01.A).
 3. Provide means for insertion to permanently record Contractor's review and approval markings and action taken by Architect.
 4. Transmittal Form for Electronic Submittals: Use electronic form acceptable to Owner, containing the following information:
 - a. Project name.
 - b. Date.
 - c. Name and address of Architect.
 - d. Name of Contractor.
 - e. Name of firm or entity that prepared submittal.
 - f. Names of subcontractor, manufacturer, and supplier.
 - g. Category and type of submittal.
 - h. Submittal purpose and description.
 - i. Specification Section number and title.
 - j. Specification paragraph number or drawing designation and generic name for each of multiple items.
 - k. Drawing number and detail references, as appropriate.
 - l. Location(s) where product is to be installed, as appropriate.
 - m. Related physical samples submitted directly.

- n. Indication of full or partial submittal.
 - o. Transmittal number, numbered consecutively.
 - p. Submittal and transmittal distribution record.
 - q. Other necessary identification.
 - r. Remarks.
5. Metadata: Include the following information as keywords in the electronic submittal file metadata:
- a. Project name.
 - b. Number and title of appropriate Specification Section.
 - c. Manufacturer name.
 - d. Product name.
- E. Options: Identify options requiring selection by Architect.
- F. Deviations and Additional Information: On an attached separate sheet, prepared on Contractor's letterhead, record relevant information, requests for data, revisions other than those requested by Architect on previous submittals, and deviations from requirements in the Contract Documents, including minor variations and limitations. Include same identification information as related submittal.
- G. Resubmittals: Make resubmittals in same form and number of copies as initial submittal.
- 1. Note date and content of previous submittal.
 - 2. Note date and content of revision in label or title block and clearly indicate extent of revision.
 - 3. Resubmit submittals until they are marked with approval notation from Architect's action stamp.
- H. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.
- I. Use for Construction: Retain complete copies of submittals on Project site. Use only final action submittals that are marked with approval notation from Architect's action stamp.

PART 2 - PRODUCTS

2.01 SUBMITTAL PROCEDURES

- A. General Submittal Procedure Requirements: Prepare and submit submittals required by individual Specification Sections. Types of submittals are indicated in individual Specification Sections.
- 1. Post electronic submittals as PDF electronic files directly to Project Web site specifically established for Project by Owner.
 - a. Architect will return annotated file. Annotate and retain one copy of file as an electronic Project record document file.
 - 2. Submit electronic submittals via email as PDF electronic files.
 - a. Architect will return annotated file. Annotate and retain one copy of file as an

electronic Project record document file.

3. Certificates and Certifications Submittals: Provide a statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity.
 - a. Provide a digital signature with digital certificate on electronically submitted certificates and certifications where indicated.
 - b. Provide a notarized statement on original paper copy certificates and certifications where indicated.
- B. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.
 1. If information must be specially prepared for submittal because standard published data are not suitable for use, submit as Shop Drawings, not as Product Data.
 2. Mark each copy of each submittal to show which products and options are applicable.
 3. Include the following information, as applicable:
 - a. Manufacturer's catalog cuts.
 - b. Manufacturer's product specifications.
 - c. Standard color charts.
 - d. Statement of compliance with specified referenced standards.
 - e. Testing by recognized testing agency.
 - f. Application of testing agency labels and seals.
 - g. Notation of coordination requirements.
 - h. Availability and delivery time information.
 4. For equipment, include the following in addition to the above, as applicable:
 - a. Wiring diagrams showing factory-installed wiring.
 - b. Printed performance curves.
 - c. Operational range diagrams.
 - d. Clearances required to other construction, if not indicated on accompanying Shop Drawings.
 5. Submit Product Data before or concurrent with Samples.
 6. Submit Product Data in the following format:
 - a. PDF electronic file.
- C. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data, unless submittal based on Architect's digital data drawing files is otherwise permitted.
 1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:
 - a. Identification of products.
 - b. Schedules.
 - c. Compliance with specified standards.
 - d. Notation of coordination requirements.
 - e. Notation of dimensions established by field measurement.
 - f. Relationship and attachment to adjoining construction clearly indicated.

-
- g. Seal and signature of professional engineer if specified.
 2. Sheet Size: Except for templates, patterns, and similar full-size drawings, submit Shop Drawings on sheets at least 8-1/2 by 11 inches, but no larger than 30 by 42 inches.
 3. Submit Shop Drawings in the following format:
 - a. PDF electronic file.
 4. BIM File Incorporation: Develop and incorporate Shop Drawing files into Building Information Model established for Project.
 - a. Prepare Shop Drawings in the following format: Same digital data software program, version, and operating system as the original Drawings.
 - b. Refer to Section 01 31 00 "Project Management and Coordination" for requirements for coordination drawings.
- D. Samples: Submit Samples for review of kind, color, pattern, and texture for a check of these characteristics with other elements and for a comparison of these characteristics between submittal and actual component as delivered and installed.
1. Transmit Samples that contain multiple, related components such as accessories together in one submittal package.
 2. Identification: Attach label on unexposed side of Samples that includes the following:
 - a. Generic description of Sample.
 - b. Product name and name of manufacturer.
 - c. Sample source.
 - d. Number and title of applicable Specification Section.
 - e. Specification paragraph number and generic name of each item.
 3. For projects where electronic submittals are required, provide corresponding electronic submittal of Sample transmittal, digital image file illustrating Sample characteristics, and identification information for record.
 4. Disposition: Maintain sets of approved Samples at Project site, available for quality-control comparisons throughout the course of construction activity. Sample sets may be used to determine final acceptance of construction associated with each set.
 - a. Samples that may be incorporated into the Work are indicated in individual Specification Sections. Such Samples must be in an undamaged condition at time of use.
 - b. Samples not incorporated into the Work, or otherwise designated as Owner's property, are the property of Contractor.
 5. Samples for Initial Selection: Submit manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available.
 - a. Number of Samples: Submit one full set(s) of available choices where color, pattern, texture, or similar characteristics are required to be selected from manufacturer's product line. Architect will return submittal with options selected.
 6. Samples for Verification: Submit full-size units or Samples of size indicated, prepared from same material to be used for the Work, cured and finished in manner specified, and physically identical with material or product proposed for

use, and that show full range of color and texture variations expected. Samples include, but are not limited to, the following: partial sections of manufactured or fabricated components; small cuts or containers of materials; complete units of repetitively used materials; swatches showing color, texture, and pattern; color range sets; and components used for independent testing and inspection.

- a. Number of Samples: Submit three sets of Samples. Architect will retain two Sample sets; remainder will be returned. Mark up and retain one returned Sample set as a project record sample.
 - 1) Submit a single Sample where assembly details, workmanship, fabrication techniques, connections, operation, and other similar characteristics are to be demonstrated.
 - 2) If variation in color, pattern, texture, or other characteristic is inherent in material or product represented by a Sample, submit at least three sets of paired units that show approximate limits of variations.
- E. Product Schedule: As required in individual Specification Sections, prepare a written summary indicating types of products required for the Work and their intended location. Include the following information in tabular form:
 1. Type of product. Include unique identifier for each product indicated in the Contract Documents or assigned by Contractor if none is indicated.
 2. Manufacturer and product name, and model number if applicable.
 3. Number and name of room or space.
 4. Location within room or space.
 5. Submit product schedule in the following format:
 - a. PDF electronic file.
- F. Coordination Drawing Submittals: Comply with requirements specified in Section 01 31 00 "Project Management and Coordination."
- G. Contractor's Construction Schedule: Comply with requirements specified in Section 01 32 00 "Construction Progress Documentation."
- H. Application for Payment and Schedule of Values: Comply with requirements specified in Section 01 29 00 "Payment Procedures."
- I. Test and Inspection Reports and Schedule of Tests and Inspections Submittals: Comply with requirements specified in Section 01 40 00 "Quality Requirements."
- J. Closeout Submittals and Maintenance Material Submittals: Comply with requirements specified in Section 01 77 00 "Closeout Procedures."
- K. Maintenance Data: Comply with requirements specified in Section 01 77 00 "Closeout Procedures."
- L. LEED Submittals: Comply with requirements specified in Section 01 81 13 "Sustainable Design Requirements."
- M. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, contact information of architects and owners, and other information specified.

-
- N. **Welding Certificates:** Prepare written certification that welding procedures and personnel comply with requirements in the Contract Documents. Submit record of Welding Procedure Specification and Procedure Qualification Record on AWS forms. Include names of firms and personnel certified.
- O. **Installer Certificates:** Submit written statements on manufacturer's letterhead certifying that Installer complies with requirements in the Contract Documents and, where required, is authorized by manufacturer for this specific Project.
- P. **Manufacturer Certificates:** Submit written statements on manufacturer's letterhead certifying that manufacturer complies with requirements in the Contract Documents. Include evidence of manufacturing experience where required.
- Q. **Product Certificates:** Submit written statements on manufacturer's letterhead certifying that product complies with requirements in the Contract Documents.
- R. **Material Certificates:** Submit written statements on manufacturer's letterhead certifying that material complies with requirements in the Contract Documents.
- S. **Material Test Reports:** Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements in the Contract Documents.
- T. **Product Test Reports:** Submit written reports indicating that current product produced by manufacturer complies with requirements in the Contract Documents. Base reports on evaluation of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.
- U. **Research Reports:** Submit written evidence, from a model code organization acceptable to authorities having jurisdiction, that product complies with building code in effect for Project. Include the following information:
1. Name of evaluation organization.
 2. Date of evaluation.
 3. Time period when report is in effect.
 4. Product and manufacturers' names.
 5. Description of product.
 6. Test procedures and results.
 7. Limitations of use.
- V. **Preconstruction Test Reports:** Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of tests performed before installation of product, for compliance with performance requirements in the Contract Documents.
- W. **Compatibility Test Reports:** Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for primers and substrate preparation needed for adhesion.
- X. **Field Test Reports:** Submit written reports indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements in the Contract Documents.
- Y. **Design Data:** Prepare and submit written and graphic information, including, but not limited to, performance and design criteria, list of applicable codes and regulations, and calculations. Include list of assumptions and other performance and design

criteria and a summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Include page numbers.

2.02 DELEGATED-DESIGN SERVICES

- A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.
 - 1. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Architect.
- B. Delegated-Design Services Certification: In addition to Shop Drawings, Product Data, and other required submittals, submit digitally signed PDF electronic file and three paper copies of certificate, signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional.
 - 1. Indicate that products and systems comply with performance and design criteria in the Contract Documents. Include list of codes, loads, and other factors used in performing these services.
- C. BIM File Incorporation: Incorporate delegated-design drawing and data files into Building Information Model established for Project.
 - 1. Prepare delegated-design drawings in the following format: Same digital data software program, version, and operating system as the original Drawings.

PART 3 - EXECUTION

3.01 CONTRACTOR'S REVIEW

- A. Action and Informational Submittals: Review each submittal and check for coordination with other Work of the Contract and for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submitting to Architect.
- B. Project Closeout and Maintenance Material Submittals: See requirements in Section 01 77 00 "Closeout Procedures."
- C. Approval Stamp: Stamp each submittal with a uniform, approval stamp. Include Project name and location, submittal number, Specification Section title and number, name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.

3.02 ARCHITECT'S ACTION

- A. Action Submittals: Architect will review each submittal, make marks to indicate corrections or revisions required, and return it. Architect will stamp each submittal with an action stamp and will mark stamp appropriately to indicate action
- B. Informational Submittals: Architect will review each submittal and will not return it, or will return it if it does not comply with requirements. Architect will forward each submittal to appropriate party.

- C. Partial submittals prepared for a portion of the Work will be reviewed when use of partial submittals has received prior approval from Architect.
- D. Incomplete submittals are unacceptable, will be considered nonresponsive, and will be returned for resubmittal without review.
- E. Submittals not required by the Contract Documents may be returned by the Architect without action.

END OF SECTION 01 33 00

SECTION 01 40 00**QUALITY REQUIREMENTS****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section includes administrative and procedural requirements for quality assurance and quality control.
- B. Testing and inspecting services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.
 - 1. Specific quality-assurance and -control requirements for individual construction activities are specified in the Sections that specify those activities. Requirements in those Sections may also cover production of standard products.
 - 2. Specified tests, inspections, and related actions do not limit Contractor's other quality-assurance and -control procedures that facilitate compliance with the Contract Document requirements.
 - 3. Requirements for Contractor to provide quality-assurance and -control services required by Architect, Owner, Commissioning Authority, or authorities having jurisdiction are not limited by provisions of this Section.
 - 4. Specific test and inspection requirements are not specified in this Section.

1.03 DEFINITIONS

- A. Quality-Assurance Services: Activities, actions, and procedures performed before and during execution of the Work to guard against defects and deficiencies and substantiate that proposed construction will comply with requirements.
- B. Quality-Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work to evaluate that actual products incorporated into the Work and completed construction comply with requirements. Services do not include contract enforcement activities performed by Architect.
- C. Mockups: Full-size physical assemblies that are constructed on-site. Mockups are constructed to verify selections made under Sample submittals; to demonstrate aesthetic effects and, where indicated, qualities of materials and execution; to review coordination, testing, or operation; to show interface between dissimilar materials; and to demonstrate compliance with specified installation tolerances. Mockups are not Samples. Unless otherwise indicated, approved mockups establish the standard by which the Work will be judged.
 - 1. Laboratory Mockups: Full-size physical assemblies constructed at testing facility to verify performance characteristics.
 - 2. Integrated Exterior Mockups: Mockups of the exterior envelope erected separately from the building but on Project site, consisting of multiple products, assemblies, and subassemblies.
 - 3. Room Mockups: Mockups of typical interior spaces complete with wall, floor, and ceiling finishes, doors, windows, millwork, casework, specialties, furnishings and

equipment, and lighting.

- D. Preconstruction Testing: Tests and inspections performed specifically for Project before products and materials are incorporated into the Work, to verify performance or compliance with specified criteria.
- E. Product Testing: Tests and inspections that are performed by an NRTL, an NVLAP, or a testing agency qualified to conduct product testing and acceptable to authorities having jurisdiction, to establish product performance and compliance with specified requirements.
- F. Source Quality-Control Testing: Tests and inspections that are performed at the source, e.g., plant, mill, factory, or shop.
- G. Field Quality-Control Testing: Tests and inspections that are performed on-site for installation of the Work and for completed Work.
- H. Testing Agency: An entity engaged to perform specific tests, inspections, or both. Testing laboratory shall mean the same as testing agency.
- I. Installer/Applicator/Erector: Contractor or another entity engaged by Contractor as an employee, Subcontractor, or Sub-subcontractor, to perform a particular construction operation, including installation, erection, application, and similar operations.
 - 1. Use of trade-specific terminology in referring to a trade or entity does not require that certain construction activities be performed by accredited or unionized individuals, or that requirements specified apply exclusively to specific trade(s).
- J. Experienced: When used with an entity or individual, "experienced" means having successfully completed a minimum of five previous projects similar in nature, size, and extent to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.

1.04 CONFLICTING REQUIREMENTS

- A. Referenced Standards: If compliance with two or more standards is specified and the standards establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer conflicting requirements that are different, but apparently equal, to Architect for a decision before proceeding.
- B. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Architect for a decision before proceeding.

1.05 ACTION SUBMITTALS

- A. Shop Drawings: For laboratory mockups, provide plans, sections, and elevations, indicating materials and size of mockup construction.
 - 1. Indicate manufacturer and model number of individual components.
 - 2. Provide axonometric drawings for conditions difficult to illustrate in two dimensions.

1.06 INFORMATIONAL SUBMITTALS

- A. Contractor's Quality-Control Plan: For quality-assurance and quality-control activities and responsibilities.
- B. Qualification Data : For Contractor's quality-control personnel.
- C. Contractor's Statement of Responsibility: When required by authorities having jurisdiction, submit copy of written statement of responsibility sent to authorities having jurisdiction before starting work on the following systems:
 - 1. Seismic-force-resisting system, designated seismic system, or component listed in the designated seismic system quality-assurance plan prepared by Architect.
 - 2. Main wind-force-resisting system or a wind-resisting component listed in the wind-force-resisting system quality-assurance plan prepared by Architect.
- D. Testing Agency Qualifications: For testing agencies specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include proof of qualifications in the form of a recent report on the inspection of the testing agency by a recognized authority.
- E. Schedule of Tests and Inspections: Prepare in tabular form and include the following:
 - 1. Specification Section number and title.
 - 2. Entity responsible for performing tests and inspections.
 - 3. Description of test and inspection.
 - 4. Identification of applicable standards.
 - 5. Identification of test and inspection methods.
 - 6. Number of tests and inspections required.
 - 7. Time schedule or time span for tests and inspections.
 - 8. Requirements for obtaining samples.
 - 9. Unique characteristics of each quality-control service.

1.07 CONTRACTOR'S QUALITY-CONTROL PLAN

- A. Quality-Control Plan, General: Submit quality-control plan within 10 days of Notice to Proceed, and not less than five days prior to preconstruction conference. Submit in format acceptable to Architect. Identify personnel, procedures, controls, instructions, tests, records, and forms to be used to carry out Contractor's quality-assurance and quality-control responsibilities. Coordinate with Contractor's construction schedule.
- B. Quality-Control Personnel Qualifications: Engage qualified full-time personnel trained and experienced in managing and executing quality-assurance and quality-control procedures similar in nature and extent to those required for Project.
 - 1. Project quality-control manager may also serve as Project superintendent
- C. Submittal Procedure: Describe procedures for ensuring compliance with requirements through review and management of submittal process. Indicate qualifications of personnel responsible for submittal review.
- D. Testing and Inspection: In quality-control plan, include a comprehensive schedule of Work requiring testing or inspection, including the following:
 - 1. Contractor-performed tests and inspections including subcontractor-performed tests and inspections. Include required tests and inspections and Contractor-elected tests and inspections.
 - 2. Special inspections required by authorities having jurisdiction and indicated on the "Statement of Special Inspections."

3. Owner-performed tests and inspections indicated in the Contract Documents, including tests and inspections indicated to be performed by the Commissioning Authority.
- E. Continuous Inspection of Workmanship: Describe process for continuous inspection during construction to identify and correct deficiencies in workmanship in addition to testing and inspection specified. Indicate types of corrective actions to be required to bring work into compliance with standards of workmanship established by Contract requirements and approved mockups.
- F. Monitoring and Documentation: Maintain testing and inspection reports including log of approved and rejected results. Include work Architect has indicated as nonconforming or defective. Indicate corrective actions taken to bring nonconforming work into compliance with requirements. Comply with requirements of authorities having jurisdiction.

1.08 REPORTS AND DOCUMENTS

- A. Test and Inspection Reports: Prepare and submit certified written reports specified in other Sections. Include the following:
 1. Date of issue.
 2. Project title and number.
 3. Name, address, and telephone number of testing agency.
 4. Dates and locations of samples and tests or inspections.
 5. Names of individuals making tests and inspections.
 6. Description of the Work and test and inspection method.
 7. Identification of product and Specification Section.
 8. Complete test or inspection data.
 9. Test and inspection results and an interpretation of test results.
 10. Record of temperature and weather conditions at time of sample taking and testing and inspecting.
 11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
 12. Name and signature of laboratory inspector.
 13. Recommendations on retesting and reinspecting.
- B. Manufacturer's Technical Representative's Field Reports: Prepare written information documenting manufacturer's technical representative's tests and inspections specified in other Sections. Include the following:
 1. Name, address, and telephone number of technical representative making report.
 2. Statement on condition of substrates and their acceptability for installation of product.
 3. Statement that products at Project site comply with requirements.
 4. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
 5. Results of operational and other tests and a statement of whether observed performance complies with requirements.
 6. Statement whether conditions, products, and installation will affect warranty.
 7. Other required items indicated in individual Specification Sections.
- C. Factory-Authorized Service Representative's Reports: Prepare written information documenting manufacturer's factory-authorized service representative's tests and inspections specified in other Sections. Include the following:
 1. Name, address, and telephone number of factory-authorized service representative making report.

2. Statement that equipment complies with requirements.
 3. Results of operational and other tests and a statement of whether observed performance complies with requirements.
 4. Statement whether conditions, products, and installation will affect warranty.
 5. Other required items indicated in individual Specification Sections.
- D. Permits, Licenses, and Certificates: For Owner's records, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents, established for compliance with standards and regulations bearing on performance of the Work.

1.09 QUALITY ASSURANCE

- A. General: Qualifications paragraphs in this article establish the minimum qualification levels required; individual Specification Sections specify additional requirements.
- B. Manufacturer Qualifications: A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
- C. Fabricator Qualifications: A firm experienced in producing products similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
- D. Installer Qualifications: A firm or individual experienced in installing, erecting, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.
- E. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or product that are similar in material, design, and extent to those indicated for this Project.
- F. Specialists: Certain Specification Sections require that specific construction activities shall be performed by entities who are recognized experts in those operations. Specialists shall satisfy qualification requirements indicated and shall be engaged for the activities indicated.
1. Requirements of authorities having jurisdiction shall supersede requirements for specialists.
- G. Testing Agency Qualifications: An NRTL, an NVLAP, or an independent agency with the experience and capability to conduct testing and inspecting indicated, as documented according to ASTM E 329; and with additional qualifications specified in individual Sections; and, where required by authorities having jurisdiction, that is acceptable to authorities.
1. NRTL: A nationally recognized testing laboratory according to 29 CFR 1910.7.
 2. NVLAP: A testing agency accredited according to NIST's National Voluntary Laboratory Accreditation Program.
- H. Manufacturer's Technical Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to observe and inspect installation of manufacturer's products that are similar in material, design, and extent

to those indicated for this Project.

- I. **Factory-Authorized Service Representative Qualifications:** An authorized representative of manufacturer who is trained and approved by manufacturer to inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.
- J. **Preconstruction Testing:** Where testing agency is indicated to perform preconstruction testing for compliance with specified requirements for performance and test methods, comply with the following:
 1. **Contractor responsibilities include the following:**
 - a. Provide test specimens representative of proposed products and construction.
 - b. Submit specimens in a timely manner with sufficient time for testing and analyzing results to prevent delaying the Work.
 - c. Provide sizes and configurations of test assemblies, mockups, and laboratory mockups to adequately demonstrate capability of products to comply with requirements.
 - d. Build site-assembled test assemblies and mockups using installers who will perform same tasks for Project.
 - e. Build laboratory mockups at testing facility using personnel, products, and methods of construction indicated for the completed Work.
 - f. When testing is complete, remove test specimens, assemblies, do not reuse products on Project.
 2. **Testing Agency Responsibilities:** Submit a certified written report of each test, inspection, and similar quality-assurance service to Architect and Commissioning Authority, with copy to Contractor. Interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from the Contract Documents.
- K. **Mockups:** Before installing portions of the Work requiring mockups, build mockups for each form of construction and finish required to comply with the following requirements, using materials indicated for the completed Work:
 1. Build mockups in location and of size indicated or, if not indicated, as directed by Architect.
 2. Notify Architect seven days in advance of dates and times when mockups will be constructed.
 3. Employ supervisory personnel who will oversee mockup construction. Employ workers that will be employed during the construction at Project.
 4. Demonstrate the proposed range of aesthetic effects and workmanship.
 5. Obtain Architect's approval of mockups before starting work, fabrication, or construction.
 - a. Allow seven days for initial review and each re-review of each mockup.
 6. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
 7. Demolish and remove mockups when directed unless otherwise indicated.

1.10 QUALITY CONTROL

- A. **Owner Responsibilities:** Where quality-control services are indicated as Owner's responsibility, Owner will engage a qualified testing agency to perform these services.

1. Owner will furnish Contractor with names, addresses, and telephone numbers of testing agencies engaged and a description of types of testing and inspecting they are engaged to perform.
 2. Payment for these services will be made from testing and inspecting allowances, as authorized by Change Orders.
 3. Costs for retesting and reinspecting construction that replaces or is necessitated by work that failed to comply with the Contract Documents will be charged to Contractor.
- B. Contractor Responsibilities: Tests and inspections not explicitly assigned to Owner are Contractor's responsibility. Perform additional quality-control activities required to verify that the Work complies with requirements, whether specified or not.
1. Unless otherwise indicated, provide quality-control services specified and those required by authorities having jurisdiction. Perform quality-control services required of Contractor by authorities having jurisdiction, whether specified or not.
 2. Where services are indicated as Contractor's responsibility, engage a qualified testing agency to perform these quality-control services.
 - a. Contractor shall not employ same entity engaged by Owner, unless agreed to in writing by Owner.
 3. Notify testing agencies at least 24 hours in advance of time when Work that requires testing or inspecting will be performed.
 4. Where quality-control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality-control service.
 5. Testing and inspecting requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
 6. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.
- C. Manufacturer's Field Services: Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections. Report results in writing as specified in Section 01 33 00 "Submittal Procedures."
- D. Manufacturer's Technical Services: Where indicated, engage a manufacturer's technical representative to observe and inspect the Work. Manufacturer's technical representative's services include participation in preinstallation conferences, examination of substrates and conditions, verification of materials, observation of Installer activities, inspection of completed portions of the Work, and submittal of written reports.
- E. Retesting/Reinspecting: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and reinspecting, for construction that replaced Work that failed to comply with the Contract Documents.
- F. Testing Agency Responsibilities: Cooperate with Architect, Commissioning Authority and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.
1. Notify Architect, Commissioning Authority and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
 2. Determine the location from which test samples will be taken and in which in-situ tests are conducted.
 3. Conduct and interpret tests and inspections and state in each report whether

- tested and inspected work complies with or deviates from requirements.
4. Submit a certified written report, in duplicate, of each test, inspection, and similar quality-control service through Contractor.
 5. Do not release, revoke, alter, or increase the Contract Document requirements or approve or accept any portion of the Work.
 6. Do not perform any duties of Contractor.
- G. Associated Services: Cooperate with agencies performing required tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:
1. Access to the Work.
 2. Incidental labor and facilities necessary to facilitate tests and inspections.
 3. Adequate quantities of representative samples of materials that require testing and inspecting. Assist agency in obtaining samples.
 4. Facilities for storage and field curing of test samples.
 5. Delivery of samples to testing agencies.
 6. Preliminary design mix proposed for use for material mixes that require control by testing agency.
 7. Security and protection for samples and for testing and inspecting equipment at Project site.
- H. Coordination: Coordinate sequence of activities to accommodate required quality-assurance and -control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspecting.
1. Schedule times for tests, inspections, obtaining samples, and similar activities.
- I. Schedule of Tests and Inspections: Prepare a schedule of tests, inspections, and similar quality-control services required by the Contract Documents as a component of Contractor's quality-control plan. Coordinate and submit concurrently with Contractor's construction schedule. Update as the Work progresses.
1. Distribution: Distribute schedule to Owner, Architect, Commissioning Authority, testing agencies, and each party involved in performance of portions of the Work where tests and inspections are required.

1.11 SPECIAL TESTS AND INSPECTIONS

- A. Special Tests and Inspections: Owner will engage a qualified special inspector to conduct special tests and inspections required by authorities having jurisdiction as the responsibility of Owner, and as follows:
- B. Special Tests and Inspections: Conducted by a qualified special inspector as required by authorities having jurisdiction, as indicated in individual Specification Sections, and as follows:
1. Verifying that manufacturer maintains detailed fabrication and quality-control procedures and reviews the completeness and adequacy of those procedures to perform the Work.
 2. Notifying Architect, Commissioning Authority, and Contractor promptly of irregularities and deficiencies observed in the Work during performance of its services.
 3. Submitting a certified written report of each test, inspection, and similar quality-control service to Architect and Commissioning Authority with copy to Contractor and to authorities having jurisdiction.
 4. Submitting a final report of special tests and inspections at Substantial

- Completion, which includes a list of unresolved deficiencies.
5. Interpreting tests and inspections and stating in each report whether tested and inspected work complies with or deviates from the Contract Documents.
 6. Retesting and reinspecting corrected work.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.01 TEST AND INSPECTION LOG

- A. Test and Inspection Log: Prepare a record of tests and inspections. Include the following:
 1. Date test or inspection was conducted.
 2. Description of the Work tested or inspected.
 3. Date test or inspection results were transmitted to Architect.
 4. Identification of testing agency or special inspector conducting test or inspection.
- B. Maintain log at Project site. Post changes and revisions as they occur. Provide access to test and inspection log for Architect's and Commissioning Authority's reference during normal working hours.

3.02 REPAIR AND PROTECTION

- A. General: On completion of testing, inspecting, sample taking, and similar services, repair damaged construction and restore substrates and finishes.
 1. Provide materials and comply with installation requirements specified in other Specification Sections or matching existing substrates and finishes. Restore patched areas and extend restoration into adjoining areas with durable seams that are as invisible as possible. Comply with the Contract Document requirements for cutting and patching in Section 01 73 00 "Execution."
- B. Protect construction exposed by or for quality-control service activities.
- C. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality-control services.

END OF SECTION 01 40 00

SECTION 01 42 00**REFERENCES****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.02 DEFINITIONS

- A. General: Basic Contract definitions are included in the Conditions of the Contract.
- B. "Approved": When used to convey Architect's action on Contractor's submittals, applications, and requests, "approved" is limited to Architect's duties and responsibilities as stated in the Conditions of the Contract.
- C. "Directed": A command or instruction by Architect. Other terms including "requested," "authorized," "selected," "required," and "permitted" have the same meaning as "directed."
- D. "Indicated": Requirements expressed by graphic representations or in written form on Drawings, in Specifications, and in other Contract Documents. Other terms including "shown," "noted," "scheduled," and "specified" have the same meaning as "indicated."
- E. "Regulations": Laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, and rules, conventions, and agreements within the construction industry that control performance of the Work.
- F. "Furnish": Supply and deliver to Project site, ready for unloading, unpacking, assembly, installation, and similar operations.
- G. "Install": Unload, temporarily store, unpack, assemble, erect, place, anchor, apply, work to dimension, finish, cure, protect, clean, and similar operations at Project site.
- H. "Provide": Furnish and install, complete and ready for the intended use.
- I. "Project Site": Space available for performing construction activities. The extent of Project site is shown on Drawings and may or may not be identical with the description of the land on which Project is to be built.

1.03 INDUSTRY STANDARDS

- A. Applicability of Standards: Unless the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract Documents to the extent referenced. Such standards are made a part of the Contract Documents by reference.
- B. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.
- C. Copies of Standards: Each entity engaged in construction on Project should be familiar with industry standards applicable to its construction activity. Copies of applicable standards are not bound with the Contract Documents.

1. Where copies of standards are needed to perform a required construction activity, obtain copies directly from publication source.

1.04 ABBREVIATIONS AND ACRONYMS

- A. Industry Organizations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities indicated in Gale's "Encyclopedia of Associations: National Organizations of the U.S." or in Columbia Books' "National Trade & Professional Associations of the United States."
- B. Industry Organizations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. This information is subject to change and is believed to be accurate as of the date of the Contract Documents.
1. AABC - Associated Air Balance Council; www.aabc.com.
 2. AAMA - American Architectural Manufacturers Association; www.aamanet.org.
 3. AAPFCO - Association of American Plant Food Control Officials; www.aapfco.org.
 4. AASHTO - American Association of State Highway and Transportation Officials; www.transportation.org.
 5. AATCC - American Association of Textile Chemists and Colorists; www.aatcc.org.
 6. ABMA - American Bearing Manufacturers Association; www.americanbearings.org.
 7. ACI - American Concrete Institute; (Formerly: ACI International); www.concrete.org.
 8. ACPA - American Concrete Pipe Association; www.concrete-pipe.org.
 9. AEIC - Association of Edison Illuminating Companies, Inc. (The); www.aeic.org.
 10. AF&PA - American Forest & Paper Association; www.afandpa.org.
 11. AGA - American Gas Association; www.aga.org.
 12. AHAM - Association of Home Appliance Manufacturers; www.aham.org.
 13. AHRI - Air-Conditioning, Heating, and Refrigeration Institute (The); www.ahrinet.org.
 14. AI - Asphalt Institute; www.asphaltinstitute.org.
 15. AIA - American Institute of Architects (The); www.aia.org.
 16. AISC - American Institute of Steel Construction; www.aisc.org.
 17. AISI - American Iron and Steel Institute; www.steel.org.
 18. AITC - American Institute of Timber Construction; www.aitc-glulam.org.
 19. AMCA - Air Movement and Control Association International, Inc.; www.amca.org.
 20. ANSI - American National Standards Institute; www.ansi.org.
 21. AOSA - Association of Official Seed Analysts, Inc.; www.aosaseed.com.
 22. APA - APA - The Engineered Wood Association; www.apawood.org.
 23. APA - Architectural Precast Association; www.archprecast.org.
 24. API - American Petroleum Institute; www.api.org.
 25. ARI - Air-Conditioning & Refrigeration Institute; (See AHRI).
 26. ARI - American Refrigeration Institute; (See AHRI).
 27. ARMA - Asphalt Roofing Manufacturers Association; www.asphaltroofing.org.
 28. ASCE - American Society of Civil Engineers; www.asce.org.
 29. ASCE/SEI - American Society of Civil Engineers/Structural Engineering Institute; (See ASCE).
 30. ASHRAE - American Society of Heating, Refrigerating and Air-Conditioning Engineers; www.ashrae.org.
 31. ASME - ASME International; (American Society of Mechanical Engineers); www.asme.org.
 32. ASSE - American Society of Safety Engineers (The); www.asse.org.
 33. ASSE - American Society of Sanitary Engineering; www.asse-plumbing.org.
 34. ASTM - ASTM International; (American Society for Testing and Materials)

- International); www.astm.org.
35. ATIS - Alliance for Telecommunications Industry Solutions; www.atis.org.
 36. AWEA - American Wind Energy Association; www.awea.org.
 37. AWI - Architectural Woodwork Institute; www.awinet.org.
 38. AWMAC - Architectural Woodwork Manufacturers Association of Canada; www.awmac.com.
 39. AWPA - American Wood Protection Association; (Formerly: American Wood-Preservers' Association); www.awpa.com.
 40. AWS - American Welding Society; www.aws.org.
 41. AWWA - American Water Works Association; www.awwa.org.
 42. BHMA - Builders Hardware Manufacturers Association; www.buildershardware.com.
 43. BIA - Brick Industry Association (The); www.gobrick.com.
 44. BICSI - BICSI, Inc.; www.bicsi.org.
 45. BIFMA - BIFMA International; (Business and Institutional Furniture Manufacturer's Association); www.bifma.com.
 46. BISSC - Baking Industry Sanitation Standards Committee; www.bissc.org.
 47. BOCA - BOCA; (Building Officials and Code Administrators International Inc.); (See ICC).
 48. BWF - Badminton World Federation; (Formerly: International Badminton Federation); www.bwfbadminton.org.
 49. CDA - Copper Development Association; www.copper.org.
 50. CEA - Canadian Electricity Association; www.electricity.ca.
 51. CEA - Consumer Electronics Association; www.ce.org.
 52. CFFA - Chemical Fabrics & Film Association, Inc.; www.chemicalfabricsandfilm.com.
 53. CFSEI - Cold-Formed Steel Engineers Institute; www.cfsei.org.
 54. CGA - Compressed Gas Association; www.cganet.com.
 55. CIMA - Cellulose Insulation Manufacturers Association; www.cellulose.org.
 56. CISCA - Ceilings & Interior Systems Construction Association; www.cisca.org.
 57. CISPI - Cast Iron Soil Pipe Institute; www.cispi.org.
 58. CLFMI - Chain Link Fence Manufacturers Institute; www.chainlinkinfo.org.
 59. CPA - Composite Panel Association; www.pbmdf.com.
 60. CRI - Carpet and Rug Institute (The); www.carpet-rug.org.
 61. CRRC - Cool Roof Rating Council; www.coolroofs.org.
 62. CRSI - Concrete Reinforcing Steel Institute; www.crsi.org.
 63. CSA - Canadian Standards Association; www.csa.ca.
 64. CSA - CSA International; (Formerly: IAS - International Approval Services); www.csa-international.org.
 65. CSI - Construction Specifications Institute (The); www.csinet.org.
 66. CSSB - Cedar Shake & Shingle Bureau; www.cedarbureau.org.
 67. CTI - Cooling Technology Institute; (Formerly: Cooling Tower Institute); www.cti.org.
 68. CWC - Composite Wood Council; (See CPA).
 69. DASMA - Door and Access Systems Manufacturers Association; www.dasma.com.
 70. DHI - Door and Hardware Institute; www.dhi.org.
 71. ECA - Electronic Components Association; www.ec-central.org.
 72. ECAMA - Electronic Components Assemblies & Materials Association; (See ECA).
 73. EIA - Electronic Industries Alliance; (See TIA).
 74. EIMA - EIFS Industry Members Association; www.eima.com.
 75. EJMA - Expansion Joint Manufacturers Association, Inc.; www.ejma.org.
 76. ESD - ESD Association; (Electrostatic Discharge Association); www.esda.org.
 77. ESTA - Entertainment Services and Technology Association; (See PLASA).
 78. EVO - Efficiency Valuation Organization; www.evo-world.org.
 79. FIBA - Federation Internationale de Basketball; (The International Basketball Federation); www.fiba.com.

80. FIVB - Federation Internationale de Volleyball; (The International Volleyball Federation); www.fivb.org.
81. FM Approvals - FM Approvals LLC; www.fmglobal.com.
82. FM Global - FM Global; (Formerly: FMG - FM Global); www.fmglobal.com.
83. FRSA - Florida Roofing, Sheet Metal & Air Conditioning Contractors Association, Inc.; www.floridarooft.com.
84. FSA - Fluid Sealing Association; www.fluidsealing.com.
85. FSC - Forest Stewardship Council U.S.; www.fscus.org.
86. GA - Gypsum Association; www.gypsum.org.
87. GANA - Glass Association of North America; www.glasswebsite.com.
88. GS - Green Seal; www.greenseal.org.
89. HI - Hydraulic Institute; www.pumps.org.
90. HI/GAMA - Hydronics Institute/Gas Appliance Manufacturers Association; (See AHRI).
91. HMMA - Hollow Metal Manufacturers Association; (See NAAMM).
92. HPVA - Hardwood Plywood & Veneer Association; www.hpva.org.
93. HPW - H. P. White Laboratory, Inc.; www.hpwhite.com.
94. IAPSC - International Association of Professional Security Consultants; www.iapsc.org.
95. IAS - International Approval Services; (See CSA).
96. ICBO - International Conference of Building Officials; (See ICC).
97. ICC - International Code Council; www.iccsafe.org.
98. ICEA - Insulated Cable Engineers Association, Inc.; www.icea.net.
99. ICPA - International Cast Polymer Alliance; www.icpa-hq.org.
100. ICRI - International Concrete Repair Institute, Inc.; www.icri.org.
101. IEC - International Electrotechnical Commission; www.iec.ch.
102. IEEE - Institute of Electrical and Electronics Engineers, Inc. (The); www.ieee.org.
103. IES - Illuminating Engineering Society; (Formerly: Illuminating Engineering Society of North America); www.ies.org.
104. IESNA - Illuminating Engineering Society of North America; (See IES).
105. IEST - Institute of Environmental Sciences and Technology; www.iest.org.
106. IGMA - Insulating Glass Manufacturers Alliance; www.igmaonline.org.
107. IGSHPA - International Ground Source Heat Pump Association; www.igshpa.okstate.edu.
108. ILI - Indiana Limestone Institute of America, Inc.; www.iliai.com.
109. Intertek - Intertek Group; (Formerly: ETL SEMCO; Intertek Testing Service NA); www.intertek.com.
110. ISA - International Society of Automation (The); (Formerly: Instrumentation, Systems, and Automation Society); www.isa.org.
111. ISAS - Instrumentation, Systems, and Automation Society (The); (See ISA).
112. ISFA - International Surface Fabricators Association; (Formerly: International Solid Surface Fabricators Association); www.isfanow.org.
113. ISO - International Organization for Standardization; www.iso.org.
114. ISSFA - International Solid Surface Fabricators Association; (See ISFA).
115. ITU - International Telecommunication Union; www.itu.int/home.
116. KCMA - Kitchen Cabinet Manufacturers Association; www.kcma.org.
117. LMA - Laminating Materials Association; (See CPA).
118. LPI - Lightning Protection Institute; www.lightning.org.
119. MBMA - Metal Building Manufacturers Association; www.mbma.com.
120. MCA - Metal Construction Association; www.metalconstruction.org.
121. MFMA - Maple Flooring Manufacturers Association, Inc.; www.maplefloor.org.
122. MFMA - Metal Framing Manufacturers Association, Inc.; www.metalframingmfg.org.
123. MHIA - Material Handling Industry of America; www.mhia.org.
124. MIA - Marble Institute of America; www.marble-institute.com.
125. MMPA - Moulding & Millwork Producers Association; (Formerly: Wood Moulding & Millwork Producers Association); www.wmmpa.com.
126. MPI - Master Painters Institute; www.paintinfo.com.

- 127.MSS - Manufacturers Standardization Society of The Valve and Fittings Industry Inc.; www.mss-hq.org.
- 128.NAAMM - National Association of Architectural Metal Manufacturers; www.naamm.org.
- 129.NACE - NACE International; (National Association of Corrosion Engineers International); www.nace.org.
- 130.NADCA - National Air Duct Cleaners Association; www.nadca.com.
- 131.NAIMA - North American Insulation Manufacturers Association; www.naima.org.
- 132.NBGQA - National Building Granite Quarries Association, Inc.; www.nbgqa.com.
- 133.NCAA - National Collegiate Athletic Association (The); www.ncaa.org.
- 134.NCMA - National Concrete Masonry Association; www.ncma.org.
- 135.NEBB - National Environmental Balancing Bureau; www.nebb.org.
- 136.NECA - National Electrical Contractors Association; www.necanet.org.
- 137.NeLMA - Northeastern Lumber Manufacturers Association; www.nelma.org.
- 138.NEMA - National Electrical Manufacturers Association; www.nema.org.
- 139.NETA - InterNational Electrical Testing Association; www.netaworld.org.
- 140.NFHS - National Federation of State High School Associations; www.nfhs.org.
- 141.NFPA - NFPA; (National Fire Protection Association); www.nfpa.org.
- 142.NFPA - NFPA International; (See NFPA).
- 143.NFRC - National Fenestration Rating Council; www.nfrc.org.
- 144.NHLA - National Hardwood Lumber Association; www.nhla.com.
- 145.NLGA - National Lumber Grades Authority; www.nlga.org.
- 146.NOFMA - National Oak Flooring Manufacturers Association; (See NWFA).
- 147.NOMMA - National Ornamental & Miscellaneous Metals Association; www.nomma.org.
- 148.NRCA - National Roofing Contractors Association; www.nrca.net.
- 149.NRMCA - National Ready Mixed Concrete Association; www.nrmca.org.
- 150.NSF - NSF International; (National Sanitation Foundation International); www.nsf.org.
- 151.NSPE - National Society of Professional Engineers; www.nspe.org.
- 152.NSSGA - National Stone, Sand & Gravel Association; www.nssga.org.
- 153.NTMA - National Terrazzo & Mosaic Association, Inc. (The); www.ntma.com.
- 154.NWFA - National Wood Flooring Association; www.nwfa.org.
- 155.PCI - Precast/Prestressed Concrete Institute; www.pci.org.
- 156.PDI - Plumbing & Drainage Institute; www.pdionline.org.
- 157.PLASA - PLASA; (Formerly: ESTA - Entertainment Services and Technology Association); www.plasa.org.
- 158.RCSC - Research Council on Structural Connections; www.boltcouncil.org.
- 159.RFCI - Resilient Floor Covering Institute; www.rfci.com.
- 160.RIS - Redwood Inspection Service; www.redwoodinspection.com.
- 161.SAE - SAE International; (Society of Automotive Engineers); www.sae.org.
- 162.SCTE - Society of Cable Telecommunications Engineers; www.scte.org.
- 163.SDI - Steel Deck Institute; www.sdi.org.
- 164.SDI - Steel Door Institute; www.steeldoor.org.
- 165.SEFA - Scientific Equipment and Furniture Association; www.sefalabs.com.
- 166.SEI/ASCE - Structural Engineering Institute/American Society of Civil Engineers; (See ASCE).
- 167.SIA - Security Industry Association; www.siaonline.org.
- 168.SJI - Steel Joist Institute; www.steeljoist.org.
- 169.SMA - Screen Manufacturers Association; www.smainfo.org.
- 170.SMACNA - Sheet Metal and Air Conditioning Contractors' National Association; www.smacna.org.
- 171.SMPTE - Society of Motion Picture and Television Engineers; www.smpte.org.
- 172.SPFA - Spray Polyurethane Foam Alliance; www.sprayfoam.org.
- 173.SPIB - Southern Pine Inspection Bureau; www.spib.org.
- 174.SPRI - Single Ply Roofing Industry; www.spri.org.
- 175.SRCC - Solar Rating and Certification Corporation; www.solar-rating.org.
- 176.SSINA - Specialty Steel Industry of North America; www.ssina.com.

- 177.SSPC - SSPC: The Society for Protective Coatings; www.sspc.org.
- 178.STI - Steel Tank Institute; www.steeltank.com.
- 179.SWI - Steel Window Institute; www.steelwindows.com.
- 180.SWPA - Submersible Wastewater Pump Association; www.swpa.org.
- 181.TCA - Tilt-Up Concrete Association; www.tilt-up.org.
- 182.TCNA - Tile Council of North America, Inc.; (Formerly: Tile Council of America); www.tileusa.com.
- 183.TEMA - Tubular Exchanger Manufacturers Association, Inc.; www.tema.org.
- 184.TIA - Telecommunications Industry Association; (Formerly: TIA/EIA - Telecommunications Industry Association/Electronic Industries Alliance); www.tiaonline.org.
- 185.TIA/EIA - Telecommunications Industry Association/Electronic Industries Alliance; (See TIA).
- 186.TMS - The Masonry Society; www.masonrysociety.org.
- 187.TPI - Truss Plate Institute; www.tpinst.org.
- 188.TPI - Turfgrass Producers International; www.turfgrasssod.org.
- 189.TRI - Tile Roofing Institute; www.tilerroofing.org.
- 190.UBC - Uniform Building Code; (See ICC).
- 191.UL - Underwriters Laboratories Inc.; www.ul.com.
- 192.UNI - Uni-Bell PVC Pipe Association; www.uni-bell.org.
- 193.USAV - USA Volleyball; www.usavolleyball.org.
- 194.USGBC - U.S. Green Building Council; www.usgbc.org.
- 195.USITT - United States Institute for Theatre Technology, Inc.; www.usitt.org.
- 196.WASTEC - Waste Equipment Technology Association; www.wastec.org.
- 197.WCLIB - West Coast Lumber Inspection Bureau; www.wclib.org.
- 198.WCMA - Window Covering Manufacturers Association; www.wcmanet.org.
- 199.WDMA - Window & Door Manufacturers Association; www.wdma.com.
- 200.WMMPA - Wood Moulding & Millwork Producers Association; (See MMPA).
- 201.WSRCA - Western States Roofing Contractors Association; www.wsrca.com.
- 202.WPA - Western Wood Products Association; www.wwpa.org.

C. Code Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. This information is believed to be accurate as of the date of the Contract Documents.

1. IAPMO - International Association of Plumbing and Mechanical Officials; www.iapmo.org.
2. ICC - International Code Council; www.iccsafe.org.
3. ICC-ES - ICC Evaluation Service, LLC; www.icc-es.org.

D. Federal Government Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. Information is subject to change and is up-to-date as of the date of the Contract Documents.

1. COE - Army Corps of Engineers; www.usace.army.mil.
2. CPSC - Consumer Product Safety Commission; www.cpsc.gov.
3. DOC - Department of Commerce; National Institute of Standards and Technology; www.nist.gov.
4. DOD - Department of Defense; <http://dodssp.daps.dla.mil>.
5. DOE - Department of Energy; www.energy.gov.
6. EPA - Environmental Protection Agency; www.epa.gov.
7. FAA - Federal Aviation Administration; www.faa.gov.
8. FG - Federal Government Publications; www.gpo.gov.
9. GSA - General Services Administration; www.gsa.gov.
10. HUD - Department of Housing and Urban Development; www.hud.gov.
11. LBL - Lawrence Berkeley National Laboratory; Environmental Energy

- Technologies Division; <http://eetd.lbl.gov>.
12. OSHA - Occupational Safety & Health Administration; www.osha.gov.
 13. SD - Department of State; www.state.gov.
 14. TRB - Transportation Research Board; National Cooperative Highway Research Program; www.trb.org.
 15. USDA - Department of Agriculture; Agriculture Research Service; U.S. Salinity Laboratory; www.ars.usda.gov.
 16. USDA - Department of Agriculture; Rural Utilities Service; www.usda.gov.
 17. USDJ - Department of Justice; Office of Justice Programs; National Institute of Justice; www.ojp.usdoj.gov.
 18. USP - U.S. Pharmacopeia; www.usp.org.
 19. USPS - United States Postal Service; www.usps.com.

E. Standards and Regulations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the standards and regulations in the following list. This information is subject to change and is believed to be accurate as of the date of the Contract Documents.

1. CFR - Code of Federal Regulations; Available from Government Printing Office; www.gpo.gov/fdsys.
2. DOD - Department of Defense; Military Specifications and Standards; Available from Department of Defense Single Stock Point; <http://dodssp.daps.dla.mil>.
3. DSCC - Defense Supply Center Columbus; (See FS).
4. FED-STD - Federal Standard; (See FS).
5. FS - Federal Specification; Available from Department of Defense Single Stock Point; <http://dodssp.daps.dla.mil>.
 - a. Available from Defense Standardization Program; www.dsp.dla.mil.
 - b. Available from General Services Administration; www.gsa.gov.
 - c. Available from National Institute of Building Sciences/Whole Building Design Guide; www.wbdg.org/ccb.
6. MILSPEC - Military Specification and Standards; (See DOD).
7. USAB - United States Access Board; www.access-board.gov.
8. USATBCB - U.S. Architectural & Transportation Barriers Compliance Board; (See USAB).

F. State Government Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. This information is subject to change and is believed to be accurate as of the date of the Contract Documents.

1. CBHF - State of California; Department of Consumer Affairs; Bureau of Electronic Appliance and Repair, Home Furnishings and Thermal Insulation; www.bearhfti.ca.gov.
2. CCR - California Code of Regulations; Office of Administrative Law; California Title 24 Energy Code; www.calregs.com.
3. CDHS - California Department of Health Services; (See CDPH).
4. CDPH - California Department of Public Health; Indoor Air Quality Program; www.cal-iaq.org.
5. CPUC - California Public Utilities Commission; www.cpuc.ca.gov.
6. SCAQMD - South Coast Air Quality Management District; www.aqmd.gov.
7. TFS - Texas Forest Service; Forest Resource Development and Sustainable Forestry; <http://txforestservation.tamu.edu>.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 42 00

SECTION 01 43 00
SYSTEMS QUALITY ASSURANCE

PART 1 - GENERAL

1.1 SUMMARY

- A. Requirements for Contractor to establish, implement and maintain an effective Quality Program to manage, control, document and assure work complies with requirements specified in the Contract Documents.

1.2 REFERENCE STANDARDS

- A. This Section incorporates by reference the latest revisions of the following documents:
1. Federal Transit Administration (FTA)
 - a. FTA Quality Guidelines.
 2. International Organization of Standards
 - a. Quality Management Systems – Fundamentals and Vocabulary - ISO 9000 -2008
 - b. Quality Management Systems – Requirements - ISO 9001 -2008

1.3 SUBMITTALS

- A. Procedures: Section 01 33 00, Submittal Procedures.
- B. Qualifications:
1. Quality Assurance Manager, within 30 days after Notice to Proceed (NTP).
 2. Independent Testing Laboratories, minimum of 30 days before scheduled use.
 3. Quality Control Inspectors.
- C. Quality Program Plan, within 60 Days after NTP.
- D. Testing Laboratory Inspection and Test Reports, within 30 days after completion of the inspection or test.
- E. List of Subcontractors and subconsultants within 45 Days after NTP. Provide updates at least 30 days prior to each new subcontractor or subconsultant beginning work on Contract.
- F. Document Control Procedure, within 15 Days after effective date of Notice to Proceed.

1.4 CONTRACTOR QUALITY ASSURANCE REQUIREMENTS

- A. Quality Assurance (QA) Manager: Assign a QA Manager responsible for managing and acting on all quality matters and who has authority to act on all quality matters as a representative of Contractor.
1. Quality Assurance Manager cannot have responsibilities for this Contract that conflict or appear to conflict with his or her responsibility for quality matters.
 2. Qualification of Contractor QA Manager:
 - a. Minimum 5 years overall quality experience.
 - b. Minimum 2 years prior experience as a QA Manager, on transit project(s) of comparable complexity to this Contract.
 - c. Minimum 2 years as a Quality Control (QC) Manager or Supervisor, Quality Engineer, Quality Auditor or QC Inspector.
 3. QA Manager must be approved by the Engineer. At the sole discretion of the Engineer, Contractor may be required to replace QA Manager.
 4. QA Manager's responsibilities include development and implementation of Quality Program Plan.
- B. Quality Program Plan (QPP):
1. Develop a plan that addresses the 15 quality elements identified in FTA Quality Guidelines.
 2. Provide descriptions of, and references to Quality procedures and work instructions, including specified requirements unique to this Contract, that relate to quality system elements defined in Quality Management Systems – Fundamentals and Vocabulary ISO 9000 and Quality Management Systems – Requirements ISO 9001.
 3. Include the following elements in Contractor QPP:
 - a. QA/QC Organization and staff, including job description and an organizational chart showing relationship between Contractor's General Manager, Project Manager, Quality Manager, Subcontractors, and consultants.
 - b. Documented Quality System.
 - c. Design Control.
 - d. Document Control and Submittal Management.
 - e. Subcontractor, Consultant and Supplier Control.
 - f. Identification, Traceability and Receiving, Handling, Storage and Control of Products, Materials and Equipment.
 - g. Process Control and control of special fabrication processes, i.e. welding, plating, and soldering.
 - h. Inspection and Testing.
 - i. Control of measuring and test equipment.

- j. Inspection and Test Reporting.
 - k. Identification, Control and Correction of Non-conforming Conditions.
 - l. Corrective Actions.
 - m. Quality Records.
 - n. Training.
 - o. Configuration control for software.
 - p. Change control for factory drawings, fabrications, assembly, wiring, testing, and as-built drawings.
- C. Independent Testing Laboratories:
- 1. Employ services of Independent Testing Laboratories if required by Contract Documents, to confirm acceptable quality of materials, parts, and equipment not currently certified by test laboratories.
 - 2. Employ only Independent Testing Laboratories that are currently certified by a nationally or state recognized regulatory agency or an industrial sponsored organization.
 - 3. Obtain approval to use Independent Testing Laboratories from the Engineer before commencing any Work for which testing is required by Contract Documents. Independent Testing Laboratories must have special inspection capability and certification.
- D. Quality Control Inspectors:
- 1. Employ qualified or certified quality control inspectors and test technicians with a minimum of 2 years quality control experience or testing experience for Work they are responsible for inspecting and testing.
 - 2. Upon request from the Engineer, provide qualifications and certifications of the quality control inspectors.
 - 3. Quality control inspectors must report directly to the Contractor's QA Manager and cannot have responsibilities for this Contract that conflict or appear to conflict with his primary responsibility for quality matters.
 - 4. Mobilize the number of experienced quality control inspectors necessary to perform the Quality Control requirements commensurate with the ratio of work crew size to inspectors and the type of work requiring specific types of inspectors.

PART 2 - PRODUCTS

Not Used

PART 3 - EXECUTION

3.1 QUALITY PROGRAM PLAN

- A. Submit ISO 9001 certification or submit a Quality Program Plan, as described.
- B. Documented Quality System:

1. Describe plans, procedures, and organization necessary to design, procure, install, inspect, and test to achieve compliance with the requirements of Contract Documents.
2. Include operations, both on-site and off-site including fabrication, manufacturing and suppliers.

3.2 SYSTEMIC FAILURES

- A. Monitor component failures during the commissioning, testing, and warranty phase.
- B. Systemic Failure: Failure of 10 percent or more of the same components used for the same function during this time period.
- C. Within 30 days of receiving notification of systemic failure, begin a program to repair or replace all components of the type involved in the systemic failure.
- D. Develop the repair or replacement for the components to remedy the nature and probable cause of the component failure.
- E. The proposed repair or replacement shall be submitted to the Engineer for approval.
- F. Components shall be replaced at no cost to the Owner.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

Not Used

4.2 PAYMENT

Not Used

END OF SECTION

SECTION 01 50 00**TEMPORARY FACILITIES AND CONTROLS****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section includes requirements for temporary utilities, support facilities, and security and protection facilities.
- B. Related Requirements:
 - 1. Section 01 10 00 "Summary" for work restrictions and limitations on utility interruptions.
 - 2. Section 01 55 26 "Maintenance of Traffic" for control of traffic on and adjacent to the site during construction.

1.03 USE CHARGES

- A. General: Installation and removal of and use charges for temporary facilities shall be included in the Contract Sum unless otherwise indicated. Allow other entities to use temporary services and facilities without cost, including, but not limited to Architect, testing agencies, and authorities having jurisdiction.
- B. Sewer Service: Pay sewer-service use charges for sewer usage by all entities for construction operations.
- C. Water Service: Pay water-service use charges for water used by all entities for construction operations.
- D. Electric Power Service: Pay electric-power-service use charges for electricity used by all entities for construction operations.

1.04 INFORMATIONAL SUBMITTALS

- A. Site Plan: Show temporary facilities, utility hookups, staging areas, and parking areas for construction personnel.
- B. Erosion- and Sedimentation-Control Plan: Show compliance with requirements of EPA Construction General Permit or authorities having jurisdiction, whichever is more stringent.
- C. Fire-Safety Program: Show compliance with requirements of NFPA 241 and authorities having jurisdiction. Indicate Contractor personnel responsible for management of fire-prevention program.
- D. Moisture-Protection Plan: Describe procedures and controls for protecting materials and construction from water absorption and damage.
 - 1. Describe delivery, handling, and storage provisions for materials subject to water absorption or water damage.

2. Indicate procedures for discarding water-damaged materials, protocols for mitigating water intrusion into completed Work, and replacing water-damaged Work.
 3. Indicate sequencing of work that requires water, such as sprayed fire-resistive materials, plastering, and terrazzo grinding, and describe plans for dealing with water from these operations. Show procedures for verifying that wet construction has dried sufficiently to permit installation of finish materials.
- E. Dust- and HVAC-Control Plan: Submit coordination drawing and narrative that indicates the dust- and HVAC-control measures proposed for use, proposed locations, and proposed time frame for their operation. Identify further options if proposed measures are later determined to be inadequate. Include the following:
1. Locations of dust-control partitions at each phase of work.
 2. HVAC system isolation schematic drawing.
 3. Location of proposed air-filtration system discharge.
 4. Waste handling procedures.
 5. Other dust-control measures.

1.05 QUALITY ASSURANCE

- A. Electric Service: Comply with NECA, NEMA, and UL standards and regulations for temporary electric service. Install service to comply with NFPA 70.
- B. Tests and Inspections: Arrange for authorities having jurisdiction to test and inspect each temporary utility before use. Obtain required certifications and permits.
- C. Accessible Temporary Egress: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines and ICC/ANSI A117.1.

1.06 PROJECT CONDITIONS

- A. Temporary Use of Permanent Facilities: Engage Installer of each permanent service to assume responsibility for operation, maintenance, and protection of each permanent service during its use as a construction facility before Owner's acceptance, regardless of previously assigned responsibilities.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Chain-Link Fencing: Minimum 2-inch, 0.148-inch- thick, galvanized-steel, chain-link fabric fencing; minimum 6 feet high with galvanized-steel pipe posts; minimum 2-3/8-inch- OD line posts and 2-7/8-inch- OD corner and pull posts, with 1-5/8-inch- OD top rails.
- B. Portable Chain-Link Fencing: Minimum 2-inch , 0.148-inch- thick, galvanized-steel, chain-link fabric fencing; minimum 6 feet high with galvanized-steel pipe posts; minimum 2-3/8-inch- OD line posts and 2-7/8-inch- OD corner and pull posts, with 1-5/8-inch- OD top and bottom rails. Provide concrete bases for supporting posts.
- C. Polyethylene Sheet: Reinforced, fire-resistive sheet, 10-mil minimum thickness, with flame-spread rating of 15 or less per ASTM E 84 and passing NFPA 701 Test Method 2.
- D. Dust-Control Adhesive-Surface Walk-off Mats: Provide mats minimum 36 by 60

inches .

- E. Insulation: Unfaced mineral-fiber blanket, manufactured from glass, slag wool, or rock wool; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively.

2.02 TEMPORARY FACILITIES

- A. Field Offices, General: Prefabricated or mobile units with serviceable finishes, temperature controls, and foundations adequate for normal loading.
- B. Common-Use Field Office: Of sufficient size to accommodate needs of Owner, Architect, and construction personnel office activities and to accommodate Project meetings specified in other Division 01 Sections. Keep office clean and orderly. Furnish and equip offices as follows:
 - 1. Furniture required for Project-site documents including file cabinets, plan tables, plan racks, and bookcases.
 - 2. Conference room of sufficient size to accommodate meetings of 10 individuals. Provide electrical power service and 120-V ac duplex receptacles, with no fewer than one receptacle on each wall. Furnish room with conference table, chairs, and 4-foot- square tack and marker boards.
 - 3. Drinking water and private toilet.
 - 4. Coffee machine and supplies.
 - 5. Heating and cooling equipment necessary to maintain a uniform indoor temperature of 68 to 72 deg F .
 - 6. Lighting fixtures capable of maintaining average illumination of 20 fc at desk height.
- C. Storage and Fabrication Sheds: Provide sheds sized, furnished, and equipped to accommodate materials and equipment for construction operations.
 - 1. Store combustible materials apart from building.

2.03 EQUIPMENT

- A. Fire Extinguishers: Portable, UL rated; with class and extinguishing agent as required by locations and classes of fire exposures.
- B. HVAC Equipment: Unless Owner authorizes use of permanent HVAC system, provide vented, self-contained, liquid-propane-gas or fuel-oil heaters with individual space thermostatic control.
 - 1. Use of gasoline-burning space heaters, open-flame heaters, or salamander-type heating units is prohibited.
 - 2. Heating Units: Listed and labeled for type of fuel being consumed, by a qualified testing agency acceptable to authorities having jurisdiction, and marked for intended location and application.
 - 3. Permanent HVAC System: If Owner authorizes use of permanent HVAC system for temporary use during construction, provide filter with MERV of 8 at each return-air grille in system and remove at end of construction and clean HVAC system as required in Section 01 77 00 "Closeout Procedures".
- C. Air-Filtration Units: Primary and secondary HEPA-filter-equipped portable units with four-stage filtration. Provide single switch for emergency shutoff. Configure to run continuously.

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

- A. Locate facilities where they will serve Project adequately and result in minimum interference with performance of the Work. Relocate and modify facilities as required by progress of the Work.
 - 1. Locate facilities to limit site disturbance as specified in Section 01 10 00 "Summary."
- B. Provide each facility ready for use when needed to avoid delay. Do not remove until facilities are no longer needed or are replaced by authorized use of completed permanent facilities.

3.02 TEMPORARY UTILITY INSTALLATION

- A. General: Install temporary service or connect to existing service.
 - 1. Arrange with utility company, Owner, and existing users for time when service can be interrupted, if necessary, to make connections for temporary services.
- B. Sewers and Drainage: Provide temporary utilities to remove effluent lawfully.
 - 1. Connect temporary sewers to municipal system as directed by authorities having jurisdiction.
- C. Water Service: Install water service and distribution piping in sizes and pressures adequate for construction.
- D. Water Service: Connect to Owner's existing water service facilities. Clean and maintain water service facilities in a condition acceptable to Owner. At Substantial Completion, restore these facilities to condition existing before initial use.
- E. Sanitary Facilities: Provide temporary toilets, wash facilities, and drinking water for use of construction personnel. Comply with requirements of authorities having jurisdiction for type, number, location, operation, and maintenance of fixtures and facilities.
 - 1. Toilets: Use of Owner's existing toilet facilities will be permitted, as long as facilities are cleaned and maintained in a condition acceptable to Owner. At Substantial Completion, restore these facilities to condition existing before initial use.
- F. Heating and Cooling: Provide temporary heating and cooling required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of low temperatures or high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed.
- G. Isolation of Work Areas in Occupied Facilities: Prevent dust, fumes, and odors from entering occupied areas.
 - 1. Prior to commencing work, isolate the HVAC system in area where work is to be performed according to coordination drawings.
 - a. Disconnect supply and return ductwork in work area from HVAC systems servicing occupied areas.

- L. Electronic Communication Service: Provide a desktop computer in the primary field office adequate for use by Architect and Owner to access Project electronic documents and maintain electronic communications. Equip computer with not less than the following:
1. Processor: Intel Pentium D or Intel CoreDuo, 3.0 GHz processing speed.
 2. Memory: 4 gigabyte.
 3. Disk Storage: 300 gigabyte hard-disk drive and combination DVD-RW/CD-RW drive.
 4. Display: 22-inch LCD monitor with 256-Mb dedicated video RAM.
 5. Full-size keyboard and mouse.
 6. Network Connectivity: 02/110BaseT Ethernet.
 7. Operating System: Microsoft Windows 8.
 8. Productivity Software:
 - a. Microsoft Office Professional, 2007 or higher, including Word, Excel, and Outlook.
 - b. Adobe Reader 9.0 or higher.
 - c. WinZip 7.0 or higher.
 9. Printer: "All-in-one" unit equipped with printer server, combining color printing, photocopying, scanning, and faxing, or separate units for each of these three functions.
 10. Internet Service: Broadband modem, router and ISP, equipped with hardware firewall, providing minimum 384 Kbps upload and 1 Mbps download speeds at each computer.
 11. Internet Security: Integrated software, providing software firewall, virus, spyware, phishing, and spam protection in a combined application.
 12. Backup: External hard drive, minimum 500 gigabyte, with automated backup software providing daily backups.

3.03 SUPPORT FACILITIES INSTALLATION

- A. General: Comply with the following:
1. Provide construction for temporary offices, shops, and sheds located within construction area or within 30 feet of building lines that is noncombustible according to ASTM E 136. Comply with NFPA 241.
 2. Maintain support facilities until Architect schedules Substantial Completion inspection. Remove before Substantial Completion. Personnel remaining after Substantial Completion will be permitted to use permanent facilities, under conditions acceptable to Owner.
- B. Temporary Roads and Paved Areas: Construct and maintain temporary roads and paved areas adequate for construction operations. Locate temporary roads and paved areas within construction limits indicated on Drawings.
1. Provide dust-control treatment that is nonpolluting and nontracking. Reapply treatment as required to minimize dust.
- C. Temporary Use of Permanent Roads and Paved Areas: Locate temporary roads and paved areas in same location as permanent roads and paved areas. Construct and maintain temporary roads and paved areas adequate for construction operations. Extend temporary roads and paved areas, within construction limits indicated, as necessary for construction operations.
1. Coordinate elevations of temporary roads and paved areas with permanent roads

- and paved areas.
 - 2. Prepare subgrade and install subbase and base for temporary roads and paved areas according to Section 31 20 00 "Earth Moving."
 - 3. Recondition base after temporary use, including removing contaminated material, regrading, proofrolling, compacting, and testing.
 - 4. Delay installation of final course of permanent hot-mix asphalt pavement until immediately before Substantial Completion. Repair hot-mix asphalt base-course pavement before installation of final course according to Section 32 12 16 "Asphalt Paving."
- D. Traffic Controls: Comply with requirements of authorities having jurisdiction.
- 1. Protect existing site improvements to remain including curbs, pavement, and utilities.
 - 2. Maintain access for fire-fighting equipment and access to fire hydrants.
- E. Parking: Provide temporary parking areas for construction personnel.
- F. Dewatering Facilities and Drains: Comply with requirements of authorities having jurisdiction. Maintain Project site, excavations, and construction free of water.
- 1. Dispose of rainwater in a lawful manner that will not result in flooding Project or adjoining properties or endanger permanent Work or temporary facilities.
 - 2. Remove snow and ice as required to minimize accumulations.
- G. Project Signs: Provide Project signs as indicated. Unauthorized signs are not permitted.
- 1. Identification Signs: Provide Project identification signs as indicated on Drawings.
 - 2. Temporary Signs: Provide other signs as indicated and as required to inform public and individuals seeking entrance to Project.
 - a. Provide temporary, directional signs for construction personnel and visitors.
 - 3. Maintain and touchup signs so they are legible at all times.
- H. Waste Disposal Facilities: Comply with requirements specified in Section 01 74 19 "Construction Waste Management and Disposal."
- I. Lifts and Hoists: Provide facilities necessary for hoisting materials and personnel.
- 1. Truck cranes and similar devices used for hoisting materials are considered "tools and equipment" and not temporary facilities.
- J. Temporary Elevator Use: Use of elevators is not permitted.
- K. Temporary Stairs: Until permanent stairs are available, provide temporary stairs where ladders are not adequate.
- L. Temporary Use of Permanent Stairs: Use of new stairs for construction traffic will be permitted, provided stairs are protected and finishes restored to new condition at time of Substantial Completion.

3.04 SECURITY AND PROTECTION FACILITIES INSTALLATION

- A. Protection of Existing Facilities: Protect existing vegetation, equipment, structures, utilities, and other improvements at Project site and on adjacent properties, except

those indicated to be removed or altered. Repair damage to existing facilities.

- B. Environmental Protection: Provide protection, operate temporary facilities, and conduct construction as required to comply with environmental regulations and that minimize possible air, waterway, and subsoil contamination or pollution or other undesirable effects.
 - 1. Comply with work restrictions specified in Section 01 10 00 "Summary."
- C. Temporary Erosion and Sedimentation Control: Comply with requirements specified on Civil Drawings."
- D. Stormwater Control: Comply with requirements of authorities having jurisdiction. Provide barriers in and around excavations and subgrade construction to prevent flooding by runoff of stormwater from heavy rains.
- E. Tree and Plant Protection: Install temporary fencing located as indicated or outside the drip line of trees to protect vegetation from damage from construction operations. Protect tree root systems from damage, flooding, and erosion.
- F. Pest Control: Engage pest-control service to recommend practices to minimize attraction and harboring of rodents, roaches, and other pests and to perform extermination and control procedures at regular intervals so Project will be free of pests and their residues at Substantial Completion. Perform control operations lawfully, using environmentally safe materials.
- G. Site Enclosure Fence: Before construction operations begin, furnish and install site enclosure fence in a manner that will prevent people and animals from easily entering site except by entrance gates.
 - 1. Extent of Fence: As indicated on Drawings.
 - 2. Maintain security by limiting number of keys and restricting distribution to authorized personnel. Furnish one set of keys to Owner
- H. Security Enclosure and Lockup: Install temporary enclosure around partially completed areas of construction. Provide lockable entrances to prevent unauthorized entrance, vandalism, theft, and similar violations of security. Lock entrances at end of each work day.
- I. Barricades, Warning Signs, and Lights: Comply with requirements of authorities having jurisdiction for erecting structurally adequate barricades, including warning signs and lighting.
- J. Temporary Egress: Maintain temporary egress from existing occupied facilities as indicated and as required by authorities having jurisdiction.
- K. Covered Walkway: Erect protective, covered walkway for passage of individuals through or adjacent to Project site. Coordinate with entrance gates, other facilities, and obstructions. Comply with regulations of authorities having jurisdiction and requirements indicated on Drawings.
 - 1. Construct covered walkways using scaffold or shoring framing.
 - 2. Provide overhead decking, protective enclosure walls, handrails, barricades, warning signs, exit signs, lights, safe and well-drained walkways, and similar provisions for protection and safe passage.
 - 3. Paint and maintain appearance of walkway for duration of the Work.
- L. Temporary Enclosures: Provide temporary enclosures for protection of construction,

in progress and completed, from exposure, foul weather, other construction operations, and similar activities. Provide temporary weathertight enclosure for building exterior.

1. Where heating or cooling is needed and permanent enclosure is incomplete, insulate temporary enclosures.
- M. Temporary Partitions: Provide floor-to-ceiling dustproof partitions to limit dust and dirt migration and to separate areas occupied by Owner from fumes and noise.
1. Construct dustproof partitions with gypsum wallboard with joints taped on occupied side, and fire-retardant-treated plywood on construction operations side.
 2. Construct dustproof partitions with two layers of 6-mil polyethylene sheet on each side. Cover floor with two layers of 6-mil polyethylene sheet, extending sheets 18 inches up the sidewalls. Overlap and tape full length of joints. Cover floor with fire-retardant-treated plywood.
 - a. Construct vestibule and airlock at each entrance through temporary partition with not less than 48 inches between doors. Maintain water-dampened foot mats in vestibule.
 3. Where fire-resistance-rated temporary partitions are indicated or are required by authorities having jurisdiction, construct partitions according to the rated assemblies.
 4. Insulate partitions to control noise transmission to occupied areas.
 5. Seal joints and perimeter. Equip partitions with gasketed dustproof doors and security locks where openings are required.
 6. Protect air-handling equipment.
 7. Provide walk-off mats at each entrance through temporary partition.
- N. Temporary Fire Protection: Install and maintain temporary fire-protection facilities of types needed to protect against reasonably predictable and controllable fire losses. Comply with NFPA 241; manage fire-prevention program.
1. Prohibit smoking in construction areas.
 2. Supervise welding operations, combustion-type temporary heating units, and similar sources of fire ignition according to requirements of authorities having jurisdiction.
 3. Develop and supervise an overall fire-prevention and -protection program for personnel at Project site. Review needs with local fire department and establish procedures to be followed. Instruct personnel in methods and procedures. Post warnings and information.
 4. Provide temporary standpipes and hoses for fire protection. Hang hoses with a warning sign stating that hoses are for fire-protection purposes only and are not to be removed. Match hose size with outlet size and equip with suitable nozzles.

3.05 MOISTURE AND MOLD CONTROL

- A. Contractor's Moisture-Protection Plan: Avoid trapping water in finished work. Document visible signs of mold that may appear during construction.
- B. Exposed Construction Phase: Before installation of weather barriers, when materials are subject to wetting and exposure and to airborne mold spores, protect as follows:
 1. Protect porous materials from water damage.
 2. Protect stored and installed material from flowing or standing water.

3. Keep porous and organic materials from coming into prolonged contact with concrete.
 4. Remove standing water from decks.
 5. Keep deck openings covered or dammed.
- C. Partially Enclosed Construction Phase: After installation of weather barriers but before full enclosure and conditioning of building, when installed materials are still subject to infiltration of moisture and ambient mold spores, protect as follows:
1. Do not load or install drywall or other porous materials or components, or items with high organic content, into partially enclosed building.
 2. Keep interior spaces reasonably clean and protected from water damage.
 3. Periodically collect and remove waste containing cellulose or other organic matter.
 4. Discard or replace water-damaged material.
 5. Do not install material that is wet.
 6. Discard, replace, or clean stored or installed material that begins to grow mold.
 7. Perform work in a sequence that allows any wet materials adequate time to dry before enclosing the material in drywall or other interior finishes.
- D. Controlled Construction Phase of Construction: After completing and sealing of the building enclosure but prior to the full operation of permanent HVAC systems, maintain as follows:
1. Control moisture and humidity inside building by maintaining effective dry-in conditions.
 2. Use permanent HVAC system to control humidity.
 3. Comply with manufacturer's written instructions for temperature, relative humidity, and exposure to water limits.

3.06 OPERATION, TERMINATION, AND REMOVAL

- A. Supervision: Enforce strict discipline in use of temporary facilities. To minimize waste and abuse, limit availability of temporary facilities to essential and intended uses.
- B. Maintenance: Maintain facilities in good operating condition until removal.
1. Maintain operation of temporary enclosures, heating, cooling, humidity control, ventilation, and similar facilities on a 24-hour basis where required to achieve indicated results and to avoid possibility of damage.
- C. Operate Project-identification-sign lighting daily from dusk until 12:00 midnight.
- D. Temporary Facility Changeover: Do not change over from using temporary security and protection facilities to permanent facilities until Substantial Completion.
- E. Termination and Removal: Remove each temporary facility when need for its service has ended, when it has been replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with temporary facility. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.
1. Materials and facilities that constitute temporary facilities are property of Contractor. Owner reserves right to take possession of Project identification signs.
 2. Remove temporary roads and paved areas not intended for or acceptable for

integration into permanent construction. Where area is intended for landscape development, remove soil and aggregate fill that do not comply with requirements for fill or subsoil. Remove materials contaminated with road oil, asphalt and other petrochemical compounds, and other substances that might impair growth of plant materials or lawns. Repair or replace street paving, curbs, and sidewalks at temporary entrances, as required by authorities having jurisdiction.

3. At Substantial Completion, repair, renovate, and clean permanent facilities used during construction period. Comply with final cleaning requirements specified in Section 01 77 00 "Closeout Procedures."

END OF SECTION 01 50 00

SECTION 01 55 26**MAINTENANCE OF TRAFFIC****PART I - GENERAL****1.1 SUMMARY****A. Description**

1. The Contractor shall maintain traffic throughout the project duration in such a manner as to:
 - a. Provide for the safe passage of automobile, train, pedestrian traffic through construction zones.
 - b. Minimize negative impacts on residents, businesses and the traveling public.
 - c. Provide convenient and logical rerouting of traffic including the use of advance warning systems and directional and informational signing, lighting and striping to provide driver friendly detours and maximize safety to the traveling public.
 - d. Maintain and provide access to property owners, customers, visitors, businesses and emergency vehicles.

1.2 REFERENCES

<u>Sponsor</u>	<u>Number</u>	<u>Subject</u>
MoDOT	600	Missouri Standard Specifications Book for Highway Construction (2011), including General Provisions and Supplemental Specifications to the 2011 Missouri Standard Specifications for Highway Construction
MoDOT	600	Standard Plans for Highway Construction – Incidental Construction
MUTCD	Part VI	Temporary Traffic Control
ADA		Americans with Disabilities Act
APWA	01 55 26	Traffic Control

1.3 DEFINITIONS

Weekday Peak Hours – Between 7 a.m. and 10 a.m., and between 3:30 p.m. and 6:30 p.m., Monday through Friday.

Weekend Peak Hours – Between 9:00 a.m. to 12:00 noon on Saturdays.

Low Volume Road – Less than 1000 vehicles per day.

Major Construction Activity – A detour, or change of geometric conditions or traffic control on a roadway for vehicular or pedestrian traffic.

Minor construction activity – Short term, no more than two days of work, and where no traffic restriction takes place. It includes shoulder or minor utility work.

1.4 SUBMITTAL

- A. Submittals to the Engineer shall be made in accordance with the requirements of the Project Quality Plan, except as modified herein.
- B. Thirty (30) working days (45 calendar days) prior to the start of any new major construction activity, the Contractor shall submit copies of the following:
 - 1. Approved Traffic Control Plans for each different phase of construction and for each construction zone affecting pedestrian and vehicular traffic.
 - a. Construction sequencing shall coordinate with each local jurisdiction and business for local special events.
 - 2. Permits and notices authorizing street closures and occupancy.
 - 3. Schedule of proposed construction sequence and estimated duration of operations.
- C. For Minor Construction Activity, the Contractor shall obtain Engineers approval 24 hours prior to the start of any work.

PART II - PRODUCTS

2.1 TEMPORARY TRAFFIC CONTROL DEVICES

A. General

Provide traffic signs and traffic control devices in "like new" condition in conformance with Manual on Uniform Traffic Control Devices (MUTCD) and MoDOT Standard Specifications Section 900, except as modified herein.

B. Temporary Signing

- 1. Use signs as indicated on the Contract Drawings.
- 2. All construction warning signs shall be 48 inch x 48 inch minimum size, unless approved by the Engineer.
- 3. Double-face signs will not be allowed except for flagger "STOP/SLOW" sign paddles.

C. Sign Supports

1. Portable Sign Supports: Portable supports shall be:
 - a. Free-standing.
 - b. Capable of supporting signs in vehicle-caused turbulence and in winds common to the area where they are used.

D. Sign Covers

1. Sign covers for temporary signs shall consist of one of the following, as approved by the Engineer:
 - a. One piece plywood or another material, if approved. Polyethylene film or canvas shall not be allowed.
 - b. Large enough to completely cover the sign.
 - c. Easy to attach to and remove from the sign without damaging the sign face.
 - d. Black, non-reflective and opaque.

2.2 TEMPORARY PAVEMENT MARKINGS

- A. Refer to Specification 32 17 23.

2.3 REMOVAL OF EXISTING PAVEMENT MARKINGS

- A. Refer to Specification 32 17 23.

PART III - EXECUTION

3.1 TRAFFIC CONTROL PLAN (TCP)

- A. The Contractor, through the Traffic Control Plan (TCP), shall meet the requirements of MoDOT Standard Specification Section 600. The Contractor shall not begin construction or close any road until the TCP has been approved in writing by the local jurisdiction and the appropriate permits and notices authorizing street closure have been obtained.
- B. If a change to the TCP is deemed necessary during construction, the Contractor must submit a revised plan to the Engineer at least seven (7) days prior to its implementation. The contractor shall also obtain approval of the local jurisdiction for the changed TCP. All proposed traffic control measures shall also be approved in writing by the Engineer prior to starting construction.
- C. Changes to the TCP, necessitated by unforeseen circumstances such as utility conflicts, must be reviewed and authorized by the Engineer at least 48 hours prior to

implementation, unless the Engineer determines an emergency situation exists requiring immediate traffic control adjustments.

- D. The Contractor shall notify the Engineer at least two weeks prior to the beginning of construction and/or the implementation of the approved TCP. The Contractor must have signs in place warning the public of street detours or closures at least seven working days prior to implementing the work. Each detour or closure must have at least two signs with the date of work as well as the street names involved.
- E. A copy of the approved TCP shall be available at each Project site in order that City, County, or State personnel may verify compliance with the specified traffic control requirements.
- F. In addition to the elements of the temporary traffic control measures specified herein, the Contractor's TCP shall also include a list of the following:
 - 1. Number of flaggers to be used, and differentiation between railroad and roadway certified flaggers.
 - 2. Number of hours for uniformed traffic controllers to be provided by the Contractor.
- G. During nonworking hours, the roadways shall be restored to travel conditions acceptable to the Engineer. Any maintenance required to restore the roadways to this condition, including pavement patching and grading or placement of steel plating, shall be done prior to opening the areas to traffic.

3.2 GENERAL REQUIREMENTS

- A. The Contractor shall coordinate with agents of municipal entities; utility owners; subcontractors and other entities to assure that adequate and proper traffic control is maintained at all times during construction in accordance with local codes and standards. The Contractor shall maintain all lanes, turning movement lanes during weekday non-peak hours. For grade crossing construction, the Contractor may reduce lanes during weekday non-peak hours and weekends, avoiding weekend peak hours where feasible. Shoulders shall be maintained where feasible. Work Zone lane widths for thru lanes shall be 11 feet minimum. 10 foot wide right turn lanes may be approved on a case by case basis by the Engineer
- B. Non-construction traffic shall be carried on a paved surface at all times unless otherwise approved by the Engineer.
- C. The Contractor shall maintain a minimum lane width of where temporary pavement is needed, as shown in the TCP or determined by the Engineer, the Contractor will comply with the methods and materials described in in other sections of the project Specifications.
- D. All Traffic Control Devices (TCD) supplied by the Contractor must be maintained in good and clean condition and meet minimum national standards for reflectivity.

-
- E. The Contractor shall not be allowed to begin operations which require traffic control until the setup of traffic control devices is completed. When clearing operations, the contractor shall allow 30 minutes for removal of traffic control devices. Temporary traffic control operations which require one-way traffic under flagger control shall be limited to off-peak hours (between 9 a.m. and 3 p.m.) daily unless approved by the Engineer.
- F. Signs
1. An inventory of all existing signs in the vicinity of each construction zone shall be conducted with the Engineer prior to construction.
 2. Existing traffic control signs may not be removed without prior approval of the Engineer.
 3. The Contractor shall cover all sign panels and sign legends, or portions thereof, that conflict with the construction zone TCP's so that none of the covered legend is readable. Materials used for covering shall be approved by the Engineer, shall be durable enough to resist deterioration due to weathering for the duration of the Project and shall not mar the surface of the sign.
 4. Upon completion of work, it is the responsibility of the Contractor to reset any existing traffic signs which are removed or relocated during construction as part of the existing traffic control plans.
 5. All construction zone traffic control devices shall bear the name, address, and phone number of the company that owns them.
 6. As needed, the Contractor shall remove and reset to a compatible location, as directed by the Engineer, all signs that are affected by construction. Any signs damaged during construction due to any reason including Contractor operations, weather, accident, and vandalism shall be replaced in kind or repaired to the satisfaction of the Engineer.
- G. The Contractor shall keep all travel lanes, sidewalks, and crosswalks free of obstructions and debris. At the end of each working day, the project shall be cleaned and secured as directed by the Engineer.
- H. The Contractor must meet air quality standards stated in the National Ambient Air Quality Standards. Measures for maintaining air quality shall include the following:
1. Control of Transported Materials
Materials with objectionable odors, dirt, soil, or other materials impacting air quality shall be covered during transports.
 2. Maintenance of Streets

- a. Streets under construction or on haul routes shall be kept free of debris or dust by the Contractor. Street sweeping equipment shall be used if necessary to clean heavily impacted streets.
 - b. Construction areas shall be watered to prevent dust blowing from exposed excavation.
3. Control of Construction Traffic
- a. Construction traffic shall be limited to minimize the increases of carbon monoxide.
 - b. Construction vehicles will not be queued or stored as to affect traffic operation in the travel ways of the approved Traffic Control Plan.

3.3 MAINTENANCE OF ACCESS

- A. The Contractor shall maintain access to all private properties, roadways, side streets, walkways, alleyways, driveways, and pedestrian/bike/equestrian paths at all times except during pouring and curing of curb/gutters and sidewalks unless closure is approved by the Engineer. When access cannot be maintained, the Contractor shall notify the affected property owner's, local jurisdiction and KCMO's Community Involvement personnel at least one week in advance of beginning work. Contractor shall update the property owner 72 hours in advance of beginning work.
- B. Access to all private properties including drives, alleys, walks and doors shall be maintained at all times. Where access is temporarily not feasible, written authorization from the Engineer must be procured prior to any interruption of access points. A Plan/schedule, prepared by the Contractor, must be approved by the local jurisdiction and the Engineer prior to any interruption.
- C. During construction, the contractor shall erect and maintain all necessary barricades, barriers, bridges and temporary means of pedestrian access to properties. These access ways shall be non-skid and a minimum of 6 feet wide and conform to current ADA requirements. The Contractor must also provide daily cleaning of pedestrian areas, to eliminate accumulation of dirt, mud, etc. Wood ramps must be constructed to prevent warping of the top surface. Use of plywood sheets or boards without supporting structure is unacceptable.
- D. Work must proceed diligently on any one access to its completion. The Contractor shall inform the property and/or business owners, the local jurisdiction and KCMO's Community Involvement person at least one week in advance when work is to be done in front of or adjacent to their property.

END OF SECTION

SECTION 01 55 26.13**MAINTENANCE OF TRAFFIC****PART I - GENERAL****1.1 SUMMARY****A. Description**

1. The Contractor shall maintain traffic throughout the project duration in such a manner as to:
 - a. Provide for the safe passage of automobile, bicycle, and pedestrian traffic through construction zones.
 - b. Minimize negative impacts on residents, businesses and the traveling public.
 - c. Provide convenient and logical rerouting of traffic including the use of advance warning systems and directional and informational signing, lighting and striping to provide driver friendly detours and maximize safety to the traveling public.
 - d. Maintain and provide access to property owners, customers, visitors, businesses and emergency vehicles.
2. The Contractor shall develop and submit to the Engineer and local jurisdictions for approval a Traffic Control Plan (TCP). The TCP shall be submitted in 11 inches x 17 inches format prepared using CAD software. Plans must be signed and sealed by a professional engineer licensed in the State of Missouri where required. The TCP shall meet the requirements of MODOT 2011 Standard Specifications.
3. The Contractor shall provide a Traffic Control Supervisor that is certified by the Missouri Department of Transportation (MODOT) or by the American Traffic Safety Services Association. The Traffic Control Supervisor oversees all traffic control operations and implements the traffic control according to the approved TCP. The responsibility of the Traffic Control Supervisor shall be in accordance with MODOT 2011 Standard Specifications. The Traffic Control Supervisor shall be available 24 hours a day, 7 days a week by cell phone or have a designated replacement for traffic emergencies.

1.2 REFERENCES

<u>Sponsor</u>	<u>Number</u>	<u>Subject</u>
MODOT		Standard Specifications for Road and Bridge Construction
MODOT		Standard Drawings for Road and Bridge Construction
SLC	1570	Traffic Regulation
SLC		Traffic Barricade Manual
MUTCD (2009)	Part VI	Temporary Traffic Control

ADA		Americans with Disabilities Act
APWA	01 55 26	Traffic Control

1.3 DEFINITIONS

Regular Working Hours – Between 7 a.m. and 5 p.m., Monday through Friday

Weekday Peak Hours – Between 7 a.m. and 10 a.m., and between 3:30 p.m. and 6:30 p.m., Monday through Friday.

Weekend Peak Hours – Between 9:00 a.m. to 12:00 noon on Saturdays.

Low Volume Road – Less than 1000 vehicles per day.

Major Construction Activity – A detour, or change of geometric conditions or traffic control on a roadway for vehicular or pedestrian traffic.

Minor construction activity – Short term, no more than two days of work, and where no traffic restriction takes place. It includes shoulder or minor utility work.

1.4 SUBMITTAL

- A. Submittals to the Engineer shall be made in accordance with the requirements of the Project Quality Plan, except as modified herein.
- B. Thirty (30) working days (45 calendar days) prior to the start of any new major construction activity, the Contractor shall submit copies of the following:
 - 1. Approved Traffic Control Plans for each different phase of construction for each grade crossing and for each construction zone affecting pedestrian and vehicular traffic.
 - a. Construction sequencing shall coordinate with each local jurisdiction and business for local special events.
 - 2. Permits and notices authorizing street closures and occupancy.
 - 3. Schedule of proposed construction sequence and estimated duration of operations.
- C. For Minor Construction Activity, the Contractor shall obtain Engineers approval 24 hours prior to the start of any work.

PART II - PRODUCTS

2.1 TEMPORARY TRAFFIC CONTROL DEVICES

- A. General

Provide traffic signs and traffic control devices in "like new" condition in conformance with Manual on Uniform Traffic Control Devices (MUTCD) and MODOT Standard Specifications, except as modified herein.

- B. Temporary Signing
 - 1. Use signs as indicated on the Contract Drawings, and in accordance with the MUTCD.
 - 2. All construction warning signs shall be 48 inch x 48 inch minimum size.
 - 3. Double-face signs will not be allowed except for flagger "STOP/SLOW" sign paddles.
- C. Sign Supports
 - 1. Portable Sign Supports: Portable supports shall be:
 - a. Free-standing.
 - b. Capable of supporting signs in vehicle-caused turbulence and in winds common to the area where they are used.
- D. Sign Covers
 - 1. Sign covers for temporary signs shall be in accordance with MODOT Standard Specifications, except as modified herein:
 - a. One piece plywood or another material, if approved. Polyethylene film or canvas shall not be allowed.
 - b. Large enough to completely cover the sign.
 - c. Easy to attach to and remove from the sign without damaging the sign face.
 - d. Black, non-reflective and opaque.

2.2 TEMPORARY PAVEMENT MARKINGS

- A. Refer to Specification 32 17 23.

2.3 REMOVAL OF EXISTING PAVEMENT MARKINGS

- A. Refer to Specification 32 17 23.

PART III - EXECUTION

3.1 TRAFFIC CONTROL PLAN (TCP)

- A. Restrictions:
 - a. The Contractor shall maintain one lane of vehicular traffic in each direction on Main Street, Grand Boulevard, Delaware Avenue (south of 5th Street), and 5th Street unless otherwise approved by the Engineer.
 - b. The Contractor may close one direction of traffic on 5th Street between Delaware Street and Grand Blvd.
 - c. Delaware Avenue north of 5th Street shall remain open at all times.

- B. Construction work that requires sidewalk closures will be permitted with Engineer approval on one side of the road for a maximum length of one block, provided that an acceptable alternate access can be provided to each affected business.
- C. Construction work that requires a temporary restriction of on-street parking will be permitted with Engineer approval on one or both sides of the road for a maximum of two blocks, plus additional length necessary to taper traffic into a configuration that supports parking.
- D. The Contractor through the Traffic Control Plan (TCP) shall meet the requirements of MODOT Standard Specifications. The Contractor shall not begin construction or close any road until the TCP has been approved in writing by the local jurisdiction and the appropriate permits and notices authorizing street closure have been obtained.
- E. If a change to the TCP is deemed necessary during construction, the Contractor must submit a revised plan to the Engineer at least seven (7) days prior to its implementation. If the change involves a request for a street closure, or closure of all traffic in one direction, the submittal must be made (14) days in advance. The contractor shall also obtain approval of the local jurisdiction for the changed TCP. All proposed traffic control measures shall also be approved in writing by the Engineer prior to starting construction.
- F. Changes to the TCP, necessitated by unforeseen circumstances such as utility conflicts, must be reviewed and authorized by the Engineer at least 48 hours prior to implementation, unless the Engineer determines an emergency situation exists requiring immediate traffic control adjustments.
- G. The Contractor shall notify the Engineer at least two weeks prior to the beginning of construction and/or the implementation of the approved TCP. The Contractor must have signs in place warning the public of street detours or closures at least seven working days prior to implementing the work. Each detour or closure must have at least two signs with the date of work as well as the street names involved.
- H. A copy of the approved TCP shall be available at each Project site in order that City, County, or State personnel may verify compliance with the specified traffic control requirements.
- I. In addition to the elements of the temporary traffic control measures specified herein, the Contractor's TCP shall also include a list of the following:
 - 1. Number of flaggers to be used, and differentiation between railroad and roadway certified flaggers.
 - 2. Number of hours for uniformed traffic controllers to be provided by the Contractor.
 - 3. A statement of compliance with KCMO Construction Safety Program.
- J. During nonworking hours, the roadways shall be restored to travel conditions acceptable to the Engineer. Any maintenance required to restore the roadways to this condition, including pavement patching and grading or placement of steel plating, shall be done prior to opening the areas to traffic.

3.2 GENERAL REQUIREMENTS

- A. Except as otherwise required for the safety or protection of persons or property at or adjacent to the project, and except as otherwise indicated in the Contract Documents, all work shall be performed during Regular Working Hours. The Contractor shall not permit the performance

of work outside of Regular Working Hours or on Saturday, Sunday or any legal holiday without written consent by the Engineer.

- B. The Contractor shall take any and all proper precautions to guard against injury to persons or damage to property until final project acceptance by the Director of Public Works. These precautions should include, but not be limited to, protection of vehicular and pedestrian traffic from injury or damage due to open excavations by the proper placement of appropriate safety devices. The Contractor shall maintain safety devices and their proper placement throughout the needed period. Construction practices should be followed that will eliminate all safety hazards as quickly as possible or practicable.
- C. The Contractor shall provide a traffic control devices and flaggers to protect, warn and guide vehicular and pedestrian traffic, and to protect individuals and equipment within the work zone.
- a. The Contractor shall monitor traffic flow through the project twice daily (once during daylight and one during darkness) and verify that the traffic control devices are in place and functioning properly. If the Contractor identifies a deficiency in any device, the Contractor shall take corrective action. No additional payment will be made for the corrective action.
- b. As soon as possible after observing a traffic control deficiency, the Engineer will report the deficiency, either verbally or in writing. After receiving the notification, if the Contractor does not make the corrective action within the agreed upon timeline, order records or suspension of the work may occur. Regardless of the severity of the deficiency, corrections shall be made as soon as possible to maintain a quality work zone. The severity of a deficiency will be categorized as follows:
- i. Category 1: Presents an immediate danger to the traveling public or works and must be addressed immediately. A Category 1 deficiency requires that temporary measures be taken immediately, and completely corrected within one hour.
- ii. Category 2: The situation doesn't pose an immediate threat to either the public or workers, but can impact the proposer functioning of the work zone. A Category 2 deficiency shall be corrected within 24 hours.
- iii. Category 3: The situation doesn't impact the functioning of the work zone, but is more of a maintenance or aesthetic issue. A Category 3 deficiency shall be corrected within 96 hours.
- c. With the Engineer's approval, the Contractor may add to the TCP any temporary traffic control devices or services the Contractor Considers necessary to adequately protect the public and the work. Device quantities may be adjusted accordingly.
- d. All changes to the TCP resulting from the Contractor staging revisions, including proposed total road closures for the Contractor's convenience, shall be submitted in writing to the Engineer for review and acceptance prior to the implementation. Device quantities may be adjusted accordingly.
- e. If the Engineer determines the need for additional traffic control devices not included in the TCP, the Contractor will be notified in writing to provide the additional devices. Device quantities may be adjusted accordingly.

- f. All traffic control devices shall be removed as soon as practical when the devices are no longer needed. When work is suspended for short periods of time, traffic control devices that are no longer appropriate shall be turned away from traffic, removed or covered.
 - g. All temporary traffic control devices shall be removed after the completion of construction and shall remain the property of the Contractor unless specified otherwise.
- D. Damage to existing utilities during construction of this project which would require immediate repair may be considered as an "emergency", and as such, may not be subject to all of the restrictions contained herein. Therefore, the Contractor should immediately contact the Engineer and the utility company whose facilities are involved whenever any utilities are damaged that may require immediate repair. Such repair work, once declared an "emergency" by the utility company or by the Engineer, shall be pursued on a continuous (24 hours per day) basis until complete or advanced to such a point that use of the roadway can be returned to normal operation and any subsequent repairs can be completed during regular working hours. However, the Engineer reserves the right to determine which utility work will be considered an "emergency". Any costs incurred by the Contractor for such "emergency" utility repair, including the cost of any additional traffic regulation that may be required, will be the Contractor's sole responsibility.
- E. The Contractor shall coordinate with agents of municipal entities; utility owners; subcontractors and other entities to assure that adequate and proper traffic control is maintained at all times during construction in accordance with local codes and standards. The Contractor shall maintain all lanes, turning movement lanes during weekday non-peak hours.
- F. Upon private business request, and approval by the Engineer, the Contractor shall erect signing to guide traffic along alternate routes and/or to alternate entrances to maintain and facilitate business access during construction.
- G. Non-construction traffic shall be carried on a paved surface at all times unless otherwise approved by the Engineer.
- H. The Contractor shall maintain a minimum lane width of eleven (11) feet where temporary pavement is needed. An additional two (2) feet shall be maintained between the edge of the traveled lane and any barrier, barricade or channelizing devices. Specific exceptions to this provision shall be approved by the Engineer prior to submittal of the TCP. The Contractor will comply with the methods and materials described in Sections 02225, 02233 and 02510.
- I. All Traffic Control Devices (TCD) supplied by the Contractor must be maintained in good and clean condition and meet minimum national standards for reflectivity.
- J. The Contractor shall not be allowed to begin operations which require traffic control until the setup of traffic control devices is completed. When clearing operations, the contractor shall allow 30 minutes for removal of traffic control devices. Temporary traffic control operations which require one-way traffic under flagger control shall be limited to off-peak hours (between 9 a.m. and 3 p.m.) daily unless approved by the Engineer.
- K. Signs
- 1. An inventory of all existing signs in the vicinity of each construction zone shall be conducted with the Engineer prior to construction.

2. Existing traffic control signs may not be removed without prior approval of the Engineer.
 3. The Contractor shall cover all sign panels and sign legends, or portions thereof, that conflict with the construction zone TCP's in accordance with the MoDOT Quality Standards for Temporary Traffic Control Devices.
 4. Upon completion of work, it is the responsibility of the Contractor to reset any existing traffic signs which are removed or relocated during construction as part of the existing traffic control plans.
 5. All construction zone traffic control devices shall bear the name, address, and phone number of the company that owns them.
 6. As needed, the Contractor shall remove and reset to a compatible location, as directed by the Engineer, all signs that are affected by construction. Any signs damaged during construction due to any reason including Contractor operations, weather, accident, and vandalism shall be replaced in kind or repaired to the satisfaction of the Engineer.
 7. All traffic control devices shall be mounted on crashworthy supports at a vertical clear height of seven(7) feet above the traveled way.
- L. The Contractor shall keep all travel lanes, sidewalks, and crosswalks free of obstructions and debris. At the end of each working day, the project shall be cleaned and secured as directed by the Engineer.
- M. The Contractor must meet air quality standards stated in the National Ambient Air Quality Standards. Measures for maintaining air quality shall include the following:
1. Control of Transported Materials
Materials with objectionable odors, dirt, soil, or other materials impacting air quality shall be covered during transports.
 2. Maintenance of Streets
 - a. Streets under construction or on haul routes shall be kept free of debris or dust by the Contractor. Street sweeping equipment shall be used if necessary to clean heavily impacted streets.
 - b. Construction areas shall be watered to prevent dust blowing from exposed excavation.
 3. Control of Construction Traffic
 - a. Construction traffic shall be limited to minimize the increases of carbon monoxide.
 - b. Construction vehicles will not be queued or stored as to affect traffic operation in the travel ways of the approved Traffic Control Plan.

3.3 MAINTENANCE OF ACCESS

- A. The Contractor shall maintain access to all private properties, roadways, side streets, walkways, alleyways, driveways, and pedestrian/bike/equestrian paths at all times except during pouring and curing of curb/gutters and sidewalks unless closure is approved by the Engineer. When access cannot be maintained, the Contractor shall notify the affected property owner's, local jurisdiction and KCMO's Community Involvement person at least one week in advance of beginning work. Contractor shall update the property owner 72 hours in advance of beginning work.
- B. At least two east/west access roads, with at least one lane in each direction, shall be open to traffic and maintained at all times through each municipality.
- C. Access to all private properties including drives, alleys, walks and doors shall be maintained at all times. Where access is temporarily not feasible, written authorization from the Engineer must be procured prior to any interruption of access points. A Plan/schedule, prepared by the Contractor, must be approved by the local jurisdiction and the Engineer prior to any interruption.
- D. During construction the contractor shall erect and maintain all necessary barricades, bridges and temporary means of pedestrian access to properties. These access ways shall be non-skid and a minimum of 6 feet wide. The Contractor must also provide daily cleaning of pedestrian areas, to eliminate accumulation of dirt, mud, etc. Wood ramps must be constructed to prevent warping of the top surface. Use of plywood sheets or boards without supporting structure is unacceptable.
- E. Work must proceed diligently on any one access to its completion. The Contractor shall inform the property and/or business owners, the local jurisdiction and KCMO's Community Involvement person at least one week in advance when work is to be done in front of or adjacent to their property.

END OF SECTION

SECTION 01 56 39**TEMPORARY TREE AND PLANT PROTECTION AND PRUNING****PART 1 - GENERAL**

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes general protection and pruning of existing trees and plants that are affected by execution of the Work, whether temporary or permanent construction.
- B. Related Sections:
1. Section 31 13 00 "Tree Removal" for removal of existing trees.
 2. Section 32 93 00 "Plants" for replacement plant installation.

1.3 DEFINITIONS

- A. Caliper: Diameter of a trunk measured by a diameter tape at 6 inches above the ground for trees up to, and including, 4-inch size; and 12 inches above the ground for trees larger than 4-inch size.
- B. Plant-Protection Zone: Area surrounding individual trees, groups of trees, shrubs, or other vegetation to be protected during construction, and indicated on Drawings.
- C. Tree-Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction, and indicated on Drawings.
- D. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples for Verification: For each type of the following:
1. Protection-Zone Fencing: Assembled Samples of manufacturer's standard size made from full-size components. Sample size 6"x6".
- C. Tree Pruning Schedule: Written schedule detailing scope and extent of pruning of trees to remain that interfere with or are affected by construction.

1. Species and size of tree.
 2. Location on site plan. Include unique identifier for each.
 3. Reason for pruning.
 4. Description of pruning to be performed.
 5. Description of maintenance following pruning.
- D. Qualification Data: For qualified arborist and tree service firm.
- E. Certification: From arborist, certifying that trees indicated to remain have been protected during construction according to recognized standards and that trees were promptly and properly treated and repaired when damaged.
- F. Maintenance Recommendations: From arborist, for care and protection of trees affected by construction during and after completing the Work.
- G. Existing Conditions: Documentation of existing trees and plantings indicated to remain, which establishes preconstruction conditions that might be misconstrued as damage caused by construction activities.
1. Use sufficiently detailed photographs or videotape.
 2. Include plans and notations to indicate specific wounds and damage conditions of each tree or other plants designated to remain.
 3. Coordinate existing conditions meeting/walk with owner for their witness to existing conditions.

1.5 QUALITY ASSURANCE

- A. Arborist Qualifications: Licensed arborist in jurisdiction where Project is located.
- B. Tree Service Firm Qualifications: An experienced tree service firm that has successfully completed temporary tree and plant protection work similar to that required for this Project and that will assign an experienced, qualified arborist to Project site during execution of the Work.
- C. Preinstallation Conference: Conduct conference at Project site.
1. Review methods and procedures related to temporary tree and plant protection including, but not limited to, the following:
 - a. Construction schedule. Verify availability of materials, personnel, and equipment needed to make progress and avoid delays.
 - b. Enforcing requirements for protection zones.
 - c. Arborist's responsibilities.
 - d. Field quality control.

1.6 PROJECT CONDITIONS

- A. The following practices are prohibited within protection zones:
1. Storage of construction materials, debris, or excavated material.
 2. Parking vehicles or equipment.
 3. Foot traffic.
 4. Erection of sheds or structures.

5. Impoundment of water.
 6. Excavation or other digging unless otherwise indicated.
 7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.
- B. Do not direct vehicle or equipment exhaust toward protection zones.
- C. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones and organic mulch.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Protection-Zone Fencing: Fencing fixed in position and meeting the following requirements. Previously used materials may be used when approved by Landscape Architect.
1. Plastic Protection-Zone Fencing: Plastic construction fencing constructed of high-density extruded and stretched polyethylene fabric with 2-inch maximum opening in pattern and weighing a minimum of 0.4 lb/ft. remaining flexible from minus 60 to plus 200 deg F inert to most chemicals and acids; minimum tensile yield strength of 2000 psi and ultimate tensile strength of 2680 psi secured with plastic bands or galvanized-steel or stainless-steel wire ties; and supported by tubular or T-shape galvanized-steel posts spaced not more than 8 feet apart.
 - a. Height: 4 feet.
 - b. Color: High-visibility orange, nonfading.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Erosion and Sedimentation Control: Examine the site to verify that temporary erosion- and sedimentation-control measures are in place. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.
- B. For the record, prepare written report, endorsed by arborist, listing conditions detrimental to tree and plant protection.

3.2 PREPARATION

- A. Locate and clearly identify trees, shrubs, and other vegetation to remain. Tie a 1-inch blue-vinyl tape around each tree trunk at 54 inches above the ground.
- B. Protect tree root systems from damage caused by runoff or spillage of noxious materials while mixing, placing, or storing construction materials. Protect root systems from ponding, eroding, or excessive wetting caused by dewatering operations.

3.3 TREE- AND PLANT-PROTECTION ZONES

- A. Protection-Zone Fencing: Install protection-zone fencing along edges of protection zones before materials or equipment are brought on the site and construction operations begin in a manner that will prevent people and animals from easily entering protected area except by entrance gates. Construct fencing so as not to obstruct safe passage or visibility at vehicle intersections where fencing is located adjacent to pedestrian walkways or in close proximity to street intersections, drives, or other vehicular circulation. See L1.01 notes for limits of protection fence.
1. Fencing: Install to comply with ASTM F 567 and with manufacturer's written instructions.
 2. Posts: Set or drive posts into ground one-third the total height of the fence without concrete footings. Where a post is located on existing paving or concrete to remain, provide appropriate means of post support acceptable to Landscape Architect.
 3. Access Gates: Install where recommended by supervising arborist adjust to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.
- B. Maintain protection zones free of weeds and trash.
- C. Repair or replace trees, shrubs, and other vegetation indicated to remain or be relocated that are damaged by construction operations, in a manner approved by Landscape Architect.
- D. Maintain protection-zone fencing and signage in good condition as acceptable to Landscape Architect and remove when construction operations are complete and equipment has been removed from the site.
1. Do not remove protection-zone fencing, even temporarily, to allow deliveries or equipment access through the protection zone.
 2. Temporary access is permitted subject to preapproval in writing by arborist if a root buffer effective against soil compaction is constructed as directed by arborist. Maintain root buffer so long as access is permitted.

3.4 EXCAVATION

- A. General: Excavate at edge of protection zones and for trenches indicated within protection zones according to requirements in Division 31.
- B. Trenching near Trees: Where utility trenches are required within protection zones, hand excavate under or around tree roots or tunnel under the roots by drilling, auger boring, or pipe jacking. Do not cut main lateral tree roots or taproots; cut only smaller roots that interfere with installation of utilities. Cut roots as required for root pruning.
- C. Redirect roots in backfill areas where possible. If encountering large, main lateral roots, expose roots beyond excavation limits as required to bend and redirect them without breaking. If encountered immediately adjacent to location of new construction and redirection is not practical, cut roots approximately 3 inches back from new construction and as required for root pruning.

- D. Do not allow exposed roots to dry out before placing permanent backfill. Provide temporary earth cover or pack with peat moss and wrap with burlap. Water and maintain in a moist condition. Temporarily support and protect roots from damage until they are permanently relocated and covered with soil.

3.5 ROOT PRUNING

- A. Prune roots that are affected by temporary and permanent construction. Prune roots as follows:
1. Cut roots manually by digging a trench and cutting exposed roots with sharp pruning instruments; do not break, tear, chop, or slant the cuts. Do not use a backhoe or other equipment that rips, tears, or pulls roots.
 2. Cut Ends: Coat cut ends of roots more than 1-1/2 inches in diameter with emulsified asphalt or other coating formulated for use on damaged plant tissues and that is acceptable to arborist.
 3. Temporarily support and protect roots from damage until they are permanently redirected and covered with soil.
 4. Cover exposed roots with burlap and water regularly.
 5. Backfill as soon as possible according to requirements in Division 31 Section "Earth Moving."
- B. Root Pruning at Edge of Protection Zone: Prune roots 12 inches outside of the protection zone, by cleanly cutting all roots to the depth of the required excavation.
- C. Root Pruning within Protection Zone: Clear and excavate by hand to the depth of the required excavation to minimize damage to root systems. Use narrow-tine spading forks, comb soil to expose roots, and cleanly cut roots as close to excavation as possible.

3.6 CROWN PRUNING

- A. Prune branches that are affected by temporary and permanent construction. Prune as follows:
1. Prune trees to remain to compensate for root loss caused by damaging or cutting root system. Provide subsequent maintenance during Contract period as recommended by arborist.
 2. Pruning Standards: Prune trees according to ANSI A300 (Part 1).
 3. Cut branches with sharp pruning instruments; do not break or chop.
 4. Do not apply pruning paint to wounds.
- B. Chip removed branches and dispose of off-site.

3.7 REGRADING

- A. Lowering Grade: Where new finish grade is indicated below existing grade around trees, slope grade beyond the protection zone. Maintain existing grades within the protection zone.
- B. Lowering Grade within Protection Zone: Where new finish grade is indicated below existing grade around trees, slope grade away from trees as recommended by arborist unless otherwise indicated.

1. Root Pruning: Prune tree roots exposed by lowering the grade. Do not cut main lateral roots or taproots; cut only smaller roots. Cut roots as required for root pruning.
- C. Raising Grade: Where new finish grade is indicated above existing grade around trees, slope grade beyond the protection zone. Maintain existing grades within the protection zone.
- D. Minor Fill within Protection Zone: Where existing grade is 2 inches or less below elevation of finish grade, fill with topsoil. Place topsoil in a single uncompacted layer and hand grade to required finish elevations.

3.8 FIELD QUALITY CONTROL

- A. Inspections: Engage a qualified arborist to direct plant-protection measures in the vicinity of trees, shrubs, and other vegetation indicated to remain and to prepare inspection reports.
- B. Contractor to water existing trees as needed or as directed by owner.

3.9 REPAIR AND REPLACEMENT

- A. General: Repair or replace trees, shrubs, and other vegetation indicated to remain or be relocated that are damaged by construction operations, in a manner approved by Landscape Architect.
 1. Submit details of proposed root cutting and tree and shrub repairs.
 2. Have arborist perform the root cutting, branch pruning, and damage repair of trees and shrubs.
 3. Treat damaged trunks, limbs, and roots according to arborist's written instructions.
 4. Perform repairs within 24 hours.
 5. Replace vegetation that cannot be repaired and restored to full-growth status, as determined by Landscape Architect.
- B. Trees: Remove and replace trees indicated to remain that are more than 25 percent dead or in an unhealthy condition before the end of the corrections period or are damaged during construction operations that Landscape Architect determines are incapable of restoring to normal growth pattern.
 1. Provide new trees of same size and species as those being replaced for each tree that measures 6" or smaller in caliper size.
 2. Provide two new trees of 4-inch caliper size for each tree being replaced that measures more than 6 inches in caliper size.
 - a. Species: Species selected by Landscape Architect.
 3. Plant and maintain new trees as specified in Division 32 Section 32 93 00 "Plants."
- C. Soil Aeration: Where directed by Landscape Architect, aerate surface soil compacted during construction. Aerate 10 feet beyond drip line and no closer than 36 inches to tree trunk. Drill 2-inch diameter holes a minimum of 12 inches deep at 24 inches o.c. Backfill holes with an equal mix of augered soil and sand.

3.10 WASTE MANAGMENT

- A. Separate and dispose of waste in accordance with the Project's Waste Management Plan.

PART 4 - MEASUREMENT

4.1 Measurement – No Separate measurement will be made for Work described in this Section.

PART 5 - PAYMENT

5.1 Payment – No separate payment will be made for temporary tree and plant protection and pruning. All costs pertaining thereto shall be included in the Contract Unit Prices for other items as listed in the Bid Form-Unit Prices.

END OF SECTION

SECTION 01 57 13**EROSION CONTROL****PART 1 - GENERAL****1.01 SCOPE OF WORK**

- A. Furnish all labor, materials, equipment and incidentals required and perform all installation, maintenance, removal, and area clean-up related to erosion and sediment control as shown on the Drawings and as specified in American Public Works Association Standard Specifications and Design Criteria Section 2100 and the Kansas City Erosion and Sediment Control Specifications as revised, adopted, and provided by the Director of Kansas City, Missouri Public Works current at the time of bidding. The work shall include, but not necessarily be limited to; installation of temporary access ways and staging areas, temporary construction entrances, silt fences, sediment removal and disposal, device maintenance, removal of temporary devices, temporary mulching, Temporary Erosion Control Blanket, and final clean-up.

1.02 GENERAL REQUIREMENTS

- A. Contractor's Responsibilities & Qualifications: Contractors must take all measures necessary to reduce erosion and sedimentation from occurring on the project. Contracts should include the installation, inspection, and maintenance of erosion and sediment control measures. Contractors should have the proper education, training, and qualifications necessary to properly install and maintain all temporary erosion and sediment control measures.
- B. Compliance with Permits: All construction projects disturbing one or more acres will have obtained a National Pollutant Discharge Elimination System (NPDES) permit from the state. Other Federal, State, or local permits may also need to be obtained for the project.
- C. Inspection and Maintenance of Plan: The Contractor and Subcontractors must maintain the integrity of the temporary erosion and sediment control measures as long as they are in place and necessary. The devices should be inspected immediately after each rainfall of ½ inch or greater and as often as the permits require. Devices should be maintained and devices that are not functioning properly should be corrected or replaced. All pipes that are to be abandoned shall be removed unless otherwise shown on the plans or approved by the Engineer.

1.03 REFERENCE STANDARDS

- A. In addition to complying with all pertinent codes and regulations, comply with the referenced or applicable portions of the American Public Works Association Standard Specifications and Design Criteria, as revised, adopted, and provided by the director of Kansas City, Missouri Public Works current at the time of bidding.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Seed and Mulch

1. Seed and Mulch shall be as specified in Section 32 92 00 entitled, "Prairie Grasses and Wildflowers".

B. Silt Fence

1. Use a synthetic filter fabric or a pervious sheet of polypropylene, nylon, polyester, or polyethylene yard, which is certified by the manufacturer or supplier as conforming to the requirements shown in the Table below:
2. Synthetic filter fabric should contain ultraviolet ray inhibitors and stabilizers to provide a minimum of 6 months of expected usable construction life at a temperature range of 0 to 120°F.

SILT FENCE FABRIC SPECIFICATIONS

<u>Physical Property</u>	<u>Minimum Requirements</u>
Filtering Efficiency	85%
Tensile Strength at (max.) Elongation	20% Standard Strength 30 lb/lin in Extra Strength- 50 lb/lin in
Slurry Flow Rate	0.3 gal/sqft/min

3. Ensure reinforcement of standard strength filter fabric, use wire fence with a minimum 14 gauge and a maximum mesh spacing of 6 inches.
4. For reinforcement of standard strength filter fabric, use wire fence with a minimum 14 gauge and a maximum mesh spacing of 6 inches.

C. Temporary Straw Bale Barrier

1. Temporary straw bale barriers intercept and detain small amounts of sediment from disturbed area of less than one acre in order to prevent sediment from leaving the site and decrease the velocity of sheet flows.
2. See Detail ESC-13 (Straw Bale Barrier) in Division III of Kansas City Metropolitan Chapter of American Public Works Association (APWA) Manual for details of materials.

D. Temporary Construction Entrance

1. A temporary construction entrance is a stabilized layer of large aggregate that is located at any point where traffic leaves a construction site and move directly onto a public road or other paved area.

2. See Detail ESC-01 (Temporary Construction Entrance) in Division III of Kansas City Metropolitan Chapter of American Public Works Association (APWA) Manual for details of materials.

E. Rock Check Dam

1. Rip rap material shall be as specified in Section 31 37 00 entitled "Rip Rap" and in accordance with the detail as shown in the construction plans.

PART 3 - EXECUTION

3.01 CONSTRUCTION DETAILS

A. General

1. All activities pertaining to erosion and sediment control shall be performed as specified in the American Public Works Association Standard Specifications and Design Criteria Section 2100 as revised, adopted, and provided by the director of Kansas City, Missouri Public Works current at the time of bidding.

B. Installation

1. Seed and Mulch Installation. Seed and Mulch shall be as specified in Section 32 92 00 entitled, "Prairie Grasses and Wildflowers".
2. Sediment Fence Installation. Sediment fences shall be positioned as indicated on the Drawings and as necessary to prevent off site movement of sediment produced by construction activities as directed by the Engineer.
 - a. Construct the sediment barrier of standard strength or extra strength synthetic filter fabrics.
 - b. Ensure that the height of the sediment fence does not exceed 18 inches above the ground surface. (Higher fences may impound volumes of water sufficient to cause failure of the structure.)
 - c. Construct the filter fabric from a continuous roll cut to the length of the barrier to avoid joints. When joints are necessary, securely fasten the filter cloth only at a support post with overlap to the next post.
 - d. Support standard strength filter fabric by wire mesh fastened securely to the upslope side of the posts using heavy duty wire staples at least 1 inch long, or tie wires. Extend the wire mesh support to the bottom of the trench.

- e. When a wire mesh support fence is used, space posts a maximum of 8 ft apart. Support posts should be driven securely into the ground to a minimum of 18 inches.
 - f. Extra strength filter fabric with 6-ft post spacing does not require wire mesh support fence. Staple or wire the filter fabric directly to the posts.
 - g. Excavate a trench approximately 4 inches wide and 8 inches deep along the proposed line of posts and upslope from the barrier.
 - h. Backfill the trench with compacted soil or gravel placed over the filter fabric.
 - i. Do not attach filter fabric to existing trees.
3. Temporary Straw Bale Barrier. Bales will be placed in a single row, lengthwise, on the contour and embedded in the soil to a depth of 3 inches.
- a. Bales must be securely anchored in place by stakes or re-bars driven through the bales or by other acceptable means to prevent displacement.
 - b. Inspection must be frequent and repair or replacement must be made promptly as needed.
4. Temporary Construction Entrance. Temporary Construction Entrance shall be installed at the site entrance. Installation shall be in accordance with Detail ESC-01 (Temporary Construction Entrance) in Division III of Kansas City Metropolitan Chapter of American Public Works Association (APWA) Manual.
- a. A temporary construction entrance is a stabilized layer of large aggregate that is located at any point where traffic leaves a construction site and move directly onto a public road or other paved area.
 - b. A temporary construction entrance provides a buffer area where construction vehicles can drop their mud to avoid transporting it onto public roads.
 - c. Avoid locating on steep slopes or at curves on public roads. If possible, locate where permanent roads will eventually be constructed.
 - d. Remove all vegetation and other unsuitable material from the foundation area, grade, and crown for positive drainage.
 - e. Place non-woven geotextile fabric on the graded foundation to improve stability.

- f. If slope towards the public road exceeds 2%, construct a 6- to 8-inch high ridge with 3H:1V side slopes across the foundation approximately 15 feet from the edge of the public road to divert runoff away from it.
 - g. Install pipe under the entrance if needed to maintain drainage ditches along public roads.
 - h. Place stone to dimensions and grade as shown on plans. Leave surface smooth and sloped for drainage.
 - i. Divert all surface runoff and drainage from the entrance to a sediment control device.
5. Rock Check Dams. Rock Check Dams shall be installed as shown on the Drawings.
- a. Rip rap rock check dams are small temporary stone dams constructed across a drainage ditch or creek.
 - b. The maximum height of the dam shall be 3 feet.
 - c. The base of the check dam can be keyed into the soil approximately 6 inches.
 - d. The maximum spacing between the dams should be such that the toe of the upstream dam is at the same elevation as the top of the downstream dam.
 - e. Stone shall be placed according to the configuration as shown in Detail ESC-15 (Rock Check Dam) in Division III of Kansas City Metropolitan Chapter of American Public Works Association (APWA) Manual. Hand or mechanical placement will be necessary to achieve complete coverage of the ditch or creek and to insure that the center of the dam is lower than the edges.
 - f. Geotextile shall be used under the stone to provide a stable foundation and to facilitate removal of the stone.

C. Maintenance and Inspections

- 1. Maintain and Inspect sediment fences at least once a week and after each rainfall and as otherwise stated in this specification. Make any required repairs immediately.
 - a. Should the fabric of a sediment fence collapse, tear, decompose, or become ineffective, replace it promptly.
 - b. Remove sediment deposits as necessary to provide adequate storage volume for the next rain and to reduce pressure on the fence. Take care to avoid undermining the fence during cleanout.

- c. Remove all fencing materials and unstable sediment deposits and bring the area to grade and stabilize it after the contributing drainage area has been properly stabilized.
 2. Maintain and Inspect the temporary construction entrance at least once a week and after each rainfall and as otherwise stated in this specification. Make any required repairs immediately.
 - a. Reshape pad as needed for proper drainage and runoff control.
 - b. Topdress with clean 2- and 3- inch stone as needed.
 - c. Immediately remove mud or sediment tracked or washed onto public road. Repair and broken road pavement immediately.
 3. Maintain and Inspect check dams at least once a week and after each rainfall and as otherwise stated in this specification. Make any required repairs immediately.
 - a. Check dams shall be inspected for sediment accumulation after each storm event of ½ inch or greater. Sediment shall be removed when it reaches one half of the original height of the dam.
 - b. Regular inspections should be made to ensure that the center of the dam is lower than the edges. Erosion caused by high flows around the edges of the dam should be corrected.
 - c. Check dams and filter fabric shall be removed when their useful life has been completed (after final acceptance of stream and associated work).

D. Removal and Final Cleanup

1. Once the site has been fully stabilized against erosion, remove sediment control devices and all accumulated silt. Dispose of silt and waste materials in proper manner. Re-grade all areas disturbed during this process and stabilize against erosion with surfacing materials as indicated on the Drawings.

END OF SECTION 01 57 13

SECTION 01 60 00**PRODUCT REQUIREMENTS****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section includes administrative and procedural requirements for selection of products for use in Project; product delivery, storage, and handling; manufacturers' standard warranties on products; special warranties; and comparable products.
- B. Related Requirements:
 - 1. Section 01 25 00 "Substitution Procedures" for requests for substitutions.
 - 2. Section 01 42 00 "References" for applicable industry standards for products specified.

1.03 DEFINITIONS

- A. Products: Items obtained for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.
 - 1. Named Products: Items identified by manufacturer's product name, including make or model number or other designation shown or listed in manufacturer's published product literature, that is current as of date of the Contract Documents.
 - 2. New Products: Items that have not previously been incorporated into another project or facility. Products salvaged or recycled from other projects are not considered new products.
 - 3. Comparable Product: Product that is demonstrated and approved through submittal process to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.
- B. Basis-of-Design Product Specification: A specification in which a specific manufacturer's product is named and accompanied by the words "basis-of-design product," including make or model number or other designation, to establish the significant qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics for purposes of evaluating comparable products of additional manufacturers named in the specification.

1.04 ACTION SUBMITTALS

- A. Comparable Product Requests: Submit request for consideration of each comparable product. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
 - 1. Include data to indicate compliance with the requirements specified in "Comparable Products" Article.
 - 2. Architect's Action: If necessary, Architect will request additional information or documentation for evaluation within one week of receipt of a comparable product

request. Architect will notify Contractor of approval or rejection of proposed comparable product request within 15 days of receipt of request, or seven days of receipt of additional information or documentation, whichever is later.

- a. Form of Approval: As specified in Section 01 33 00 "Submittal Procedures."
 - b. Use product specified if Architect does not issue a decision on use of a comparable product request within time allocated.
- B. Basis-of-Design Product Specification Submittal: Comply with requirements in Section 01 33 00 "Submittal Procedures." Show compliance with requirements.

1.05 QUALITY ASSURANCE

- A. Compatibility of Options: If Contractor is given option of selecting between two or more products for use on Project, select product compatible with products previously selected, even if previously selected products were also options.
1. Each contractor is responsible for providing products and construction methods compatible with products and construction methods of other contractors.
 2. If a dispute arises between contractors over concurrently selectable but incompatible products, Architect will determine which products shall be used.

1.06 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft and vandalism. Comply with manufacturer's written instructions.
- B. Delivery and Handling:
1. Schedule delivery to minimize long-term storage at Project site and to prevent overcrowding of construction spaces.
 2. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
 3. Deliver products to Project site in an undamaged condition in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
 4. Inspect products on delivery to determine compliance with the Contract Documents and to determine that products are undamaged and properly protected.
- C. Storage:
1. Store products to allow for inspection and measurement of quantity or counting of units.
 2. Store materials in a manner that will not endanger Project structure.
 3. Store products that are subject to damage by the elements, under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation.
 4. Protect foam plastic from exposure to sunlight, except to extent necessary for period of installation and concealment.
 5. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
 6. Protect stored products from damage and liquids from freezing.
 7. Provide a secure location and enclosure at Project site for storage of materials and equipment by Owner's construction forces. Coordinate location with Owner.

1.07 PRODUCT WARRANTIES

- A. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.
 - 1. Manufacturer's Warranty: Written warranty furnished by individual manufacturer for a particular product and specifically endorsed by manufacturer to Owner.
 - 2. Special Warranty: Written warranty required by the Contract Documents to provide specific rights for Owner.
- B. Special Warranties: Prepare a written document that contains appropriate terms and identification, ready for execution.
 - 1. Manufacturer's Standard Form: Modified to include Project-specific information and properly executed.
 - 2. Specified Form: When specified forms are included with the Specifications, prepare a written document using indicated form properly executed.
 - 3. See other Sections for specific content requirements and particular requirements for submitting special warranties.
- C. Submittal Time: Comply with requirements in Section 01 77 00 "Closeout Procedures."

PART 2 - PRODUCTS

2.01 PRODUCT SELECTION PROCEDURES

- A. General Product Requirements: Provide products that comply with the Contract Documents, are undamaged and, unless otherwise indicated, are new at time of installation.
 - 1. Provide products complying with the Buy American Act, 2009.
 - 2. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.
 - 3. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.
 - 4. Owner reserves the right to limit selection to products with warranties not in conflict with requirements of the Contract Documents.
 - 5. Where products are accompanied by the term "as selected," Architect will make selection.
 - 6. Descriptive, performance, and reference standard requirements in the Specifications establish salient characteristics of products.
- B. Product Selection Procedures:
 - 1. Product: Where Specifications name a single manufacturer and product, provide the named product that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
 - 2. Manufacturer/Source: Where Specifications name a single manufacturer or source, provide a product by the named manufacturer or source that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
 - 3. Products:

- a. Restricted List: Where Specifications include a list of names of both manufacturers and products, provide one of the products listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered unless otherwise indicated.
 - b. Nonrestricted List: Where Specifications include a list of names of both available manufacturers and products, provide one of the products listed, or an unnamed product, that complies with requirements. Comply with requirements in "Comparable Products" Article for consideration of an unnamed product.
4. Manufacturers:
- a. Restricted List: Where Specifications include a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will be considered unless otherwise indicated.
 - b. Nonrestricted List: Where Specifications include a list of available manufacturers, provide a product by one of the manufacturers listed, or a product by an unnamed manufacturer, that complies with requirements. Comply with requirements in "Comparable Products" Article for consideration of an unnamed manufacturer's product.
5. Basis-of-Design Product: Where Specifications name a product, or refer to a product indicated on Drawings, and include a list of manufacturers, provide the specified or indicated product or a comparable product by one of the other named manufacturers. Drawings and Specifications indicate sizes, profiles, dimensions, and other characteristics that are based on the product named. Comply with requirements in "Comparable Products" Article for consideration of an unnamed product by one of the other named manufacturers.
- C. Visual Matching Specification: Where Specifications require "match Architect's sample", provide a product that complies with requirements and matches Architect's sample. Architect's decision will be final on whether a proposed product matches.
1. If no product available within specified category matches and complies with other specified requirements, comply with requirements in Section 01 25 00 "Substitution Procedures" for proposal of product.
- D. Visual Selection Specification: Where Specifications include the phrase "as selected by Architect from manufacturer's full range" or similar phrase, select a product that complies with requirements. Architect will select color, gloss, pattern, density, or texture from manufacturer's product line that includes both standard and premium items.

2.02 COMPARABLE PRODUCTS

- A. Conditions for Consideration: Architect will consider Contractor's request for comparable product when the following conditions are satisfied. If the following conditions are not satisfied, Architect may return requests without action, except to record noncompliance with these requirements:
1. Evidence that the proposed product does not require revisions to the Contract Documents, that it is consistent with the Contract Documents and will produce the indicated results, and that it is compatible with other portions of the Work.
 2. Detailed comparison of significant qualities of proposed product with those named in the Specifications. Significant qualities include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.

3. Evidence that proposed product provides specified warranty.
4. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners, if requested.
5. Samples, if requested.

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 60 00

SECTION 01 73 00**EXECUTION****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section includes general administrative and procedural requirements governing execution of the Work including, but not limited to, the following:

- 1. Construction layout.
- 2. Field engineering and surveying.
- 3. Installation of the Work.
- 4. Cutting and patching.
- 5. Coordination of Owner-installed products.
- 6. Progress cleaning.
- 7. Starting and adjusting.
- 8. Protection of installed construction.

- B. Related Requirements:

- 1. Section 01 10 00 "Summary" for limits on use of Project site.
- 2. Section 01 33 00 "Submittal Procedures" for submitting surveys.
- 3. Section 01 77 00 "Closeout Procedures" for submitting final property survey with Project Record Documents, recording of Owner-accepted deviations from indicated lines and levels, and final cleaning.
- 4. Section 02 41 19 "Selective Demolition" for demolition and removal of selected portions of the building.
- 5. Section 07 84 13 "Penetration Firestopping" for patching penetrations in fire-rated construction.

1.03 DEFINITIONS

- A. Cutting: Removal of in-place construction necessary to permit installation or performance of other work.
- B. Patching: Fitting and repair work required to restore construction to original conditions after installation of other work.

1.04 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For professional engineer.
- B. Certificates: Submit certificate signed by professional engineer certifying that location and elevation of improvements comply with requirements.
- C. Cutting and Patching Plan: Submit plan describing procedures at least 10 days prior to the time cutting and patching will be performed. Include the following information:
 - 1. Extent: Describe reason for and extent of each occurrence of cutting and patching.

2. Changes to In-Place Construction: Describe anticipated results. Include changes to structural elements and operating components as well as changes in building appearance and other significant visual elements.
 3. Products: List products to be used for patching and firms or entities that will perform patching work.
 4. Dates: Indicate when cutting and patching will be performed.
 5. Utilities and Mechanical and Electrical Systems: List services and systems that cutting and patching procedures will disturb or affect. List services and systems that will be relocated and those that will be temporarily out of service. Indicate length of time permanent services and systems will be disrupted.
 - a. Include description of provisions for temporary services and systems during interruption of permanent services and systems.
- D. Landfill Receipts: Submit copy of receipts issued by a landfill facility, licensed to accept hazardous materials, for hazardous waste disposal.
- E. Certified Surveys: Submit two copies signed by professional engineer.
- F. Final Property Survey: Submit 10 copies showing the Work performed and record survey data.

1.05 QUALITY ASSURANCE

- A. Land Surveyor Qualifications: A professional land surveyor who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing land-surveying services of the kind indicated.
- B. Cutting and Patching: Comply with requirements for and limitations on cutting and patching of construction elements specified in Section 01 73 29 "Cutting and Patching."
- C. Manufacturer's Installation Instructions: Obtain and maintain on-site manufacturer's written recommendations and instructions for installation of products and equipment.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. General: Comply with requirements specified in other Sections.
 1. For projects requiring compliance with sustainable design and construction practices and procedures, use products for patching that comply with requirements in Section 01 81 13.13 "Sustainable Design Requirements - LEED for New Construction and Major Renovations," Section 01 81 13.16 "Sustainable Design Requirements - LEED for Commercial Interiors," Section 01 81 13.19 "Sustainable Design Requirements - LEED for Core and Shell Development," and Section 01 81 13.23 "Sustainable Design Requirements - LEED for Schools."
- B. In-Place Materials: Use materials for patching identical to in-place materials. For exposed surfaces, use materials that visually match in-place adjacent surfaces to the fullest extent possible.
 1. If identical materials are unavailable or cannot be used, use materials that, when installed, will provide a match acceptable to Architect for the visual and functional performance of in-place materials.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Existing Conditions: The existence and location of underground and other utilities and construction indicated as existing are not guaranteed. Before beginning sitework, investigate and verify the existence and location of underground utilities and other construction affecting the Work.
 - 1. Before construction, verify the location and invert elevation at points of connection of sanitary sewer, storm sewer, and water-service piping; underground electrical services, and other utilities.
 - 2. Furnish location data for work related to Project that must be performed by public utilities serving Project site.
- B. Examination and Acceptance of Conditions: Before proceeding with each component of the Work, examine substrates, areas, and conditions, with Installer or Applicator present where indicated, for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations.
 - 1. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.
 - 2. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.
 - 3. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
- C. Written Report: Where a written report listing conditions detrimental to performance of the Work is required by other Sections, include the following:
 - 1. Description of the Work.
 - 2. List of detrimental conditions, including substrates.
 - 3. List of unacceptable installation tolerances.
 - 4. Recommended corrections.
- D. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

3.02 PREPARATION

- A. Existing Utility Information: Furnish information to Owner and local utility that is necessary to adjust, move, or relocate existing utility structures, utility poles, lines, services, or other utility appurtenances located in or affected by construction. Coordinate with authorities having jurisdiction.
- B. Field Measurements: Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
- C. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.
- D. Review of Contract Documents and Field Conditions: Immediately on discovery of the need for clarification of the Contract Documents caused by differing field conditions outside the control of Contractor, submit a request for information to

Architect according to requirements in Section 01 31 00 "Project Management and Coordination."

3.03 CONSTRUCTION LAYOUT

- A. Verification: Before proceeding to lay out the Work, verify layout information shown on Drawings, in relation to the property survey and existing benchmarks. If discrepancies are discovered, notify Architect promptly.
- B. General: Engage a professional engineer to lay out the Work using accepted surveying practices.
 - 1. Establish benchmarks and control points to set lines and levels at each story of construction and elsewhere as needed to locate each element of Project.
 - 2. Establish limits on use of Project site.
 - 3. Establish dimensions within tolerances indicated. Do not scale Drawings to obtain required dimensions.
 - 4. Inform installers of lines and levels to which they must comply.
 - 5. Check the location, level and plumb, of every major element as the Work progresses.
 - 6. Notify Architect when deviations from required lines and levels exceed allowable tolerances.
 - 7. Close site surveys with an error of closure equal to or less than the standard established by authorities having jurisdiction.
- C. Site Improvements: Locate and lay out site improvements, including pavements, grading, fill and topsoil placement, utility slopes, and rim and invert elevations.
- D. Building Lines and Levels: Locate and lay out control lines and levels for structures, building foundations, column grids, and floor levels, including those required for mechanical and electrical work. Transfer survey markings and elevations for use with control lines and levels. Level foundations and piers from two or more locations.
- E. Record Log: Maintain a log of layout control work. Record deviations from required lines and levels. Include beginning and ending dates and times of surveys, weather conditions, name and duty of each survey party member, and types of instruments and tapes used. Make the log available for reference by Architect.

3.04 FIELD ENGINEERING

- A. Identification: Owner will identify existing benchmarks, control points, and property corners.
- B. Reference Points: Locate existing permanent benchmarks, control points, and similar reference points before beginning the Work. Preserve and protect permanent benchmarks and control points during construction operations.
 - 1. Do not change or relocate existing benchmarks or control points without prior written approval of Architect. Report lost or destroyed permanent benchmarks or control points promptly. Report the need to relocate permanent benchmarks or control points to Architect before proceeding.
 - 2. Replace lost or destroyed permanent benchmarks and control points promptly. Base replacements on the original survey control points.
- C. Benchmarks: Establish and maintain a minimum of two permanent benchmarks on Project site, referenced to data established by survey control points. Comply with authorities having jurisdiction for type and size of benchmark.

1. Record benchmark locations, with horizontal and vertical data, on Project Record Documents.
 2. Where the actual location or elevation of layout points cannot be marked, provide temporary reference points sufficient to locate the Work.
 3. Remove temporary reference points when no longer needed. Restore marked construction to its original condition.
- D. Certified Survey: On completion of foundation walls, major site improvements, and other work requiring field-engineering services, prepare a certified survey showing dimensions, locations, angles, and elevations of construction and sitework.
- E. Final Property Survey: Engage a [land surveyor] [professional engineer] to prepare a final property survey showing significant features (real property) for Project. Include on the survey a certification, signed by [land surveyor] [professional engineer], that principal metes, bounds, lines, and levels of Project are accurately positioned as shown on the survey.
1. Show boundary lines, monuments, streets, site improvements and utilities, existing improvements and significant vegetation, adjoining properties, acreage, grade contours, and the distance and bearing from a site corner to a legal point.
 2. Recording: At Substantial Completion, have the final property survey recorded by or with authorities having jurisdiction as the official "property survey."

3.05 INSTALLATION

- A. General: Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.
1. Make vertical work plumb and make horizontal work level.
 2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.
 3. Conceal pipes, ducts, and wiring in finished areas unless otherwise indicated.
 4. Maintain minimum headroom clearance of 96 inches in occupied spaces and 90 inches in unoccupied spaces.
- B. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.
- C. Install products at the time and under conditions that will ensure the best possible results. Maintain conditions required for product performance until Substantial Completion.
- D. Conduct construction operations so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy.
- E. Sequence the Work and allow adequate clearances to accommodate movement of construction items on site and placement in permanent locations.
- F. Tools and Equipment: Do not use tools or equipment that produce harmful noise levels.
- G. Templates: Obtain and distribute to the parties involved templates for work specified to be factory prepared and field installed. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing products to comply with indicated requirements.
- H. Attachment: Provide blocking and attachment plates and anchors and fasteners of

adequate size and number to securely anchor each component in place, accurately located and aligned with other portions of the Work. Where size and type of attachments are not indicated, verify size and type required for load conditions.

1. Mounting Heights: Where mounting heights are not indicated, mount components at heights directed by Architect.
 2. Allow for building movement, including thermal expansion and contraction.
 3. Coordinate installation of anchorages. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.
- I. Joints: Make joints of uniform width. Where joint locations in exposed work are not indicated, arrange joints for the best visual effect. Fit exposed connections together to form hairline joints.
- J. Hazardous Materials: Use products, cleaners, and installation materials that are not considered hazardous.

3.06 OWNER-INSTALLED PRODUCTS

- A. Site Access: Provide access to Project site for Owner's construction personnel.
- B. Coordination: Coordinate construction and operations of the Work with work performed by Owner's construction personnel.
1. Construction Schedule: Inform Owner of Contractor's preferred construction schedule for Owner's portion of the Work. Adjust construction schedule based on a mutually agreeable timetable. Notify Owner if changes to schedule are required due to differences in actual construction progress.
 2. Preinstallation Conferences: Include Owner's construction personnel at preinstallation conferences covering portions of the Work that are to receive Owner's work. Attend preinstallation conferences conducted by Owner's construction personnel if portions of the Work depend on Owner's construction.

3.07 PROGRESS CLEANING

- A. General: Clean Project site and work areas daily, including common areas. Enforce requirements strictly. Dispose of materials lawfully.
1. Comply with requirements in NFPA 241 for removal of combustible waste materials and debris.
 2. Do not hold waste materials more than seven days during normal weather or three days if the temperature is expected to rise above 80 deg F .
 3. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, according to regulations.
 - a. Use containers intended for holding waste materials of type to be stored.
 4. Coordinate progress cleaning for joint-use areas where Contractor and other contractors are working concurrently.
- B. Site: Maintain Project site free of waste materials and debris.
- C. Work Areas: Clean areas where work is in progress to the level of cleanliness necessary for proper execution of the Work.

1. Remove liquid spills promptly.
 2. Where dust would impair proper execution of the Work, broom-clean or vacuum the entire work area, as appropriate.
- D. Installed Work: Keep installed work clean. Clean installed surfaces according to written instructions of manufacturer or fabricator of product installed, using only cleaning materials specifically recommended. If specific cleaning materials are not recommended, use cleaning materials that are not hazardous to health or property and that will not damage exposed surfaces.
- E. Concealed Spaces: Remove debris from concealed spaces before enclosing the space.
- F. Exposed Surfaces in Finished Areas: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.
- G. Waste Disposal: Do not bury or burn waste materials on-site. Do not wash waste materials down sewers or into waterways. Comply with waste disposal requirements in Section 01 74 19 "Construction Waste Management and Disposal."
- H. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.
- I. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.
- J. Limiting Exposures: Supervise construction operations to assure that no part of the construction, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.

3.08 STARTING AND ADJUSTING

- A. Coordinate startup and adjusting of equipment and operating components with requirements in Section 01 91 13 "General Commissioning Requirements."
- B. Start equipment and operating components to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.
- C. Adjust equipment for proper operation. Adjust operating components for proper operation without binding.
- D. Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- E. Manufacturer's Field Service: Comply with qualification requirements in Section 01 40 00 "Quality Requirements."

3.09 PROTECTION OF INSTALLED CONSTRUCTION

- A. Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at time of Substantial Completion.
- B. Comply with manufacturer's written instructions for temperature and relative humidity.

END OF SECTION 01 73 00

SECTION 01 73 29**CUTTING AND PATCHING****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section includes general administrative and procedural requirements governing cutting and patching Work
- B. Related Requirements:
 - 1. Section 01 73 00 "Execution" for installation of the Work, protection of installed construction, and correction of the Work.
 - 2. Section 07 84 13 "Penetration Firestopping" for patching penetrations in fire-rated construction.

1.03 DEFINITIONS

- A. Cutting: Removal of in-place construction necessary to permit installation or performance of other work.
- B. Patching: Fitting and repair work required to restore construction to original conditions after installation of other work.

1.04 INFORMATIONAL SUBMITTALS

- A. Cutting and Patching Plan: Submit plan describing procedures at least 10 days prior to the time cutting and patching will be performed. Include the following information:
 - 1. Extent: Describe reason for and extent of each occurrence of cutting and patching.
 - 2. Changes to In-Place Construction: Describe anticipated results. Include changes to structural elements and operating components as well as changes in building appearance and other significant visual elements.
 - 3. Products: List products to be used for patching and firms or entities that will perform patching work.
 - 4. Dates: Indicate when cutting and patching will be performed.
 - 5. Utilities and Mechanical and Electrical Systems: List services and systems that cutting and patching procedures will disturb or affect. List services and systems that will be relocated and those that will be temporarily out of service. Indicate length of time permanent services and systems will be disrupted.
 - a. Include description of provisions for temporary services and systems during interruption of permanent services and systems.

1.05 QUALITY ASSURANCE

- A. Cutting and Patching: Comply with requirements for and limitations on cutting and patching of construction elements.

1. Structural Elements: When cutting and patching structural elements, notify Architect of locations and details of cutting and await directions from Architect before proceeding. Shore, brace, and support structural elements during cutting and patching. Do not cut and patch structural elements in a manner that could change their load-carrying capacity or increase deflection
 2. Operational Elements: Do not cut and patch operating elements and related components in a manner that results in reducing their capacity to perform as intended or that results in increased maintenance or decreased operational life or safety
 3. Other Construction Elements: Do not cut and patch other construction elements or components in a manner that could change their load-carrying capacity, that results in reducing their capacity to perform as intended, or that results in increased maintenance or decreased operational life or safety
 4. Visual Elements: Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch exposed construction in a manner that would, in Architect's opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.
- B. Cutting and Patching Conference: Before proceeding, meet at Project site with parties involved in cutting and patching, including mechanical and electrical trades. Review areas of potential interference and conflict. Coordinate procedures and resolve potential conflicts before proceeding.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. General: Comply with requirements specified in other Sections.
1. For projects requiring compliance with sustainable design and construction practices and procedures, use products for patching that comply with requirements in Section 01 81 13 "Sustainable Design."
- B. In-Place Materials: Use materials for patching identical to in-place materials. For exposed surfaces, use materials that visually match in-place adjacent surfaces to the fullest extent possible.
1. If identical materials are unavailable or cannot be used, use materials that, when installed, will provide a match acceptable to Architect for the visual and functional performance of in-place materials.

PART 3 - EXECUTION

3.01 CUTTING AND PATCHING

- A. Cutting and Patching, General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.
1. Cut in-place construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.
- B. Temporary Support: Provide temporary support of work to be cut.

-
- C. Protection: Protect in-place construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.
- D. Cutting: Cut in-place construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original Installer; comply with original Installer's written recommendations.
1. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots neatly to minimum size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
 2. Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.
 3. Concrete and Masonry: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.
 4. Excavating and Backfilling: Comply with requirements in applicable Sections where required by cutting and patching operations.
 5. Mechanical and Electrical Services: Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after cutting.
 6. Proceed with patching after construction operations requiring cutting are complete.
- E. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other work. Patch with durable seams that are as invisible as practicable. Provide materials and comply with installation requirements specified in other Sections, where applicable.
1. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate physical integrity of installation.
 2. Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will minimize evidence of patching and refinishing.
 - a. Clean piping, conduit, and similar features before applying paint or other finishing materials.
 - b. Restore damaged pipe covering to its original condition.
 3. Floors and Walls: Where walls or partitions that are removed extend one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of uniform finish, color, texture, and appearance. Remove in-place floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.
 - a. Where patching occurs in a painted surface, prepare substrate and apply primer and intermediate paint coats appropriate for substrate over the patch, and apply final paint coat over entire unbroken surface containing the patch. Provide additional coats until patch blends with adjacent surfaces.
 4. Ceilings: Patch, repair, or rehang in-place ceilings as necessary to provide an even-plane surface of uniform appearance.
 5. Exterior Building Enclosure: Patch components in a manner that restores enclosure to a weathertight condition and ensures thermal and moisture integrity of building enclosure.

- F. Cleaning: Clean areas and spaces where cutting and patching are performed. Remove paint, mortar, oils, putty, and similar materials from adjacent finished surfaces.

END OF SECTION 01 73 29

SECTION 01 74 19**CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section includes administrative and procedural requirements for the following:
 - 1. Salvaging nonhazardous construction waste.
 - 2. Recycling nonhazardous construction waste.
 - 3. Disposing of nonhazardous construction waste.
- B. Related Requirements:
 - 1. Section 04 20 00 "Unit Masonry" for disposal requirements for masonry waste.
 - 2. Section 31 22 00 "Site Preparation and Grading" for disposition of waste resulting from site clearing and removal of above- and below-grade improvements.

1.03 DEFINITIONS

- A. Construction Waste: Building and site improvement materials and other solid waste resulting from construction, remodeling, renovation, or repair operations. Construction waste includes packaging.
- B. Disposal: Removal off-site of construction waste and subsequent sale, recycling, reuse, or deposit in landfill or incinerator acceptable to authorities having jurisdiction.
- C. Recycle: Recovery of construction waste for subsequent processing in preparation for reuse.
- D. Salvage: Recovery of construction waste and subsequent sale or reuse in another facility.
- E. Salvage and Reuse: Recovery of construction waste and subsequent incorporation into the Work.

1.04 PERFORMANCE REQUIREMENTS

- A. General: Achieve end-of-Project rates for salvage/recycling of 75 percent by weight of total non-hazardous solid waste generated by the Work. Practice efficient waste management in the use of materials in the course of the Work. Use all reasonable means to divert construction and demolition waste from landfills and incinerators. Facilitate recycling and salvage of materials.

1.05 ACTION SUBMITTALS

- A. Waste Management Plan: Submit plan within 30 days of date established for the Notice to Proceed.

1.06 INFORMATIONAL SUBMITTALS

-
- A. Waste Reduction Progress Reports: Concurrent with each Application for Payment, submit report. Use Form CWM-7 for construction waste. Include the following information:
1. Material category.
 2. Generation point of waste.
 3. Total quantity of waste in **tons**.
 4. Quantity of waste salvaged, both estimated and actual in **tons**.
 5. Quantity of waste recycled, both estimated and actual in **tons**.
 6. Total quantity of waste recovered (salvaged plus recycled) in **tons**.
 7. Total quantity of waste recovered (salvaged plus recycled) as a percentage of total waste.
- B. Waste Reduction Calculations: Before request for Substantial Completion, submit calculated end-of-Project rates for salvage, recycling, and disposal as a percentage of total waste generated by the Work.
- C. Records of Donations: Indicate receipt and acceptance of salvageable waste donated to individuals and organizations. Indicate whether organization is tax exempt.
- D. Records of Sales: Indicate receipt and acceptance of salvageable waste sold to individuals and organizations. Indicate whether organization is tax exempt.
- E. Recycling and Processing Facility Records: Indicate receipt and acceptance of recyclable waste by recycling and processing facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.
- F. Landfill and Incinerator Disposal Records: Indicate receipt and acceptance of waste by landfills and incinerator facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.
- G. LEED Submittal: LEED letter template for Credit MR 2, signed by Contractor, tabulating total waste material, quantities diverted and means by which it is diverted, and statement that requirements for the credit have been met.
- H. Qualification Data: For waste management coordinator.

1.07 QUALITY ASSURANCE

- A. Waste Management Coordinator Qualifications: Experienced firm, with a record of successful waste management coordination of projects with similar requirements, that employs a LEED-Accredited Professional, certified by the USGBC, as waste management coordinator. Waste management coordinator may also serve as LEED coordinator.
- B. Regulatory Requirements: Comply with hauling and disposal regulations of authorities having jurisdiction.
- C. Waste Management Conference: Conduct conference at Project site to comply with requirements in Section 01 31 00 "Project Management and Coordination." Review methods and procedures related to waste management including, but not limited to, the following:
1. Review and discuss waste management plan including responsibilities of waste management coordinator.
 2. Review requirements for documenting quantities of each type of waste and its

- disposition.
3. Review and finalize procedures for materials separation and verify availability of containers and bins needed to avoid delays.
 4. Review procedures for periodic waste collection and transportation to recycling and disposal facilities.
 5. Review waste management requirements for each trade.

1.08 WASTE MANAGEMENT PLAN

- A. General: Develop a waste management plan according to ASTM E 1609 and requirements of this Section. Plan shall consist of waste identification, waste reduction work plan, and cost/revenue analysis. Indicate quantities by weight or volume, but use same units of measure throughout waste management plan.
- B. Waste Identification: Indicate anticipated types and quantities of site-clearing and construction waste generated by the Work. Use Form CWM-1 for construction waste. Include estimated quantities and assumptions for estimates.
- C. Waste Reduction Work Plan: List each type of waste and whether it will be salvaged, recycled, or disposed of in landfill or incinerator. Use Form CWM-3 for construction waste. Include points of waste generation, total quantity of each type of waste, quantity for each means of recovery, and handling and transportation procedures.
 1. Salvaged Materials for Reuse: For materials that will be salvaged and reused in this Project, describe methods for preparing salvaged materials before incorporation into the Work.
 2. Salvaged Materials for Sale: For materials that will be sold to individuals and organizations, include list of their names, addresses, and telephone numbers.
 3. Salvaged Materials for Donation: For materials that will be donated to individuals and organizations, include list of their names, addresses, and telephone numbers.
 4. Recycled Materials: Include list of local receivers and processors and type of recycled materials each will accept. Include names, addresses, and telephone numbers.
 5. Disposed Materials: Indicate how and where materials will be disposed of. Include name, address, and telephone number of each landfill and incinerator facility.
 6. Handling and Transportation Procedures: Include method that will be used for separating recyclable waste including sizes of containers, container labeling, and designated location on Project site where materials separation will be located.
- D. Cost/Revenue Analysis: Indicate total cost of waste disposal as if there was no waste management plan and net additional cost or net savings resulting from implementing waste management plan. Use Form CWM-5 for construction waste. Include the following:
 1. Total quantity of waste.
 2. Estimated cost of disposal (cost per unit). Include hauling and tipping fees and cost of collection containers for each type of waste.
 3. Total cost of disposal (with no waste management).
 4. Revenue from salvaged materials.
 5. Revenue from recycled materials.
 6. Savings in hauling and tipping fees by donating materials.
 7. Savings in hauling and tipping fees that are avoided.
 8. Handling and transportation costs. Include cost of collection containers for each type of waste.
 9. Net additional cost or net savings from waste management plan.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.01 PLAN IMPLEMENTATION

- A. General: Implement approved waste management plan. Provide handling, containers, storage, signage, transportation, and other items as required to implement waste management plan during the entire duration of the Contract.
 - 1. Comply with operation, termination, and removal requirements in Section 01 50 00 "Temporary Facilities and Controls."
- B. Waste Management Coordinator: Engage a waste management coordinator to be responsible for implementing, monitoring, and reporting status of waste management work plan. Coordinator shall be present at Project site full time for duration of Project.
- C. Training: Train workers, subcontractors, and suppliers on proper waste management procedures, as appropriate for the Work.
 - 1. Distribute waste management plan to everyone concerned within three days of submittal return.
 - 2. Distribute waste management plan to entities when they first begin work on-site. Review plan procedures and locations established for salvage, recycling, and disposal.
- D. Site Access and Temporary Controls: Conduct waste management operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
 - 1. Designate and label specific areas on Project site necessary for separating materials that are to be salvaged, recycled, reused, donated, and sold.
 - 2. Comply with Section 01 50 00 "Temporary Facilities and Controls" for controlling dust and dirt, environmental protection, and noise control.

3.02 RECYCLING CONSTRUCTION WASTE, GENERAL

- A. General: Recycle paper and beverage containers used by on-site workers.
- B. Recycling Incentives: Revenues, savings, rebates, tax credits, and other incentives received for recycling waste materials shall be shared equally by Authority and Contractor.
- C. Preparation of Waste: Prepare and maintain recyclable waste materials according to recycling or reuse facility requirements. Maintain materials free of dirt, adhesives, solvents, petroleum contamination, and other substances deleterious to the recycling process.
- D. Procedures: Separate recyclable waste from other waste materials, trash, and debris. Separate recyclable waste by type at Project site to the maximum extent practical according to approved construction waste management plan.
 - 1. Provide appropriately marked containers or bins for controlling recyclable waste until removed from Project site. Include list of acceptable and unacceptable materials at each container and bin.

- a. Inspect containers and bins for contamination and remove contaminated materials if found.
2. Stockpile processed materials on-site without intermixing with other materials. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
3. Stockpile materials away from construction area. Do not store within drip line of remaining trees.
4. Store components off the ground and protect from the weather.
5. Remove recyclable waste from Authority's property and transport to recycling receiver or processor.

3.03 RECYCLING CONSTRUCTION WASTE

A. Packaging:

1. Cardboard and Boxes: Break down packaging into flat sheets. Bundle and store in a dry location.
2. Polystyrene Packaging: Separate and bag materials.
3. Pallets: As much as possible, require deliveries using pallets to remove pallets from Project site. For pallets that remain on-site, break down pallets into component wood pieces and comply with requirements for recycling wood.
4. Crates: Break down crates into component wood pieces and comply with requirements for recycling wood.

B. Wood Materials:

1. Clean Cut-Offs of Lumber: Grind or chip into small pieces.
2. Clean Sawdust: Bag sawdust that does not contain painted or treated wood.
 - a. Comply with requirements in Section 32 93 00 "Plants" for use of clean sawdust as organic mulch.

C. Gypsum Board: Stack large clean pieces on wood pallets or in container and store in a dry location.

1. Clean Gypsum Board: Grind scraps of clean gypsum board using small mobile chipper or hammer mill. Screen out paper after grinding.
 - a. Comply with requirements in Section 32 93 00 "Plants" for use of clean ground gypsum board as inorganic soil amendment.

3.04 DISPOSAL OF WASTE

A. General: Except for items or materials to be salvaged, recycled, or otherwise reused, remove waste materials from Project site and legally dispose of them in a landfill or incinerator acceptable to authorities having jurisdiction.

1. Except as otherwise specified, do not allow waste materials that are to be disposed of accumulate on-site.
2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.

B. Burning: Do not burn waste materials.

C. Burning: Burning of waste materials is permitted only at designated areas on Authority's property, provided required permits are obtained. Provide full-time monitoring for burning materials until fires are extinguished.

- D. Disposal: Remove waste materials and dispose of at designated spoil areas on Authority's property.
- E. Disposal: Remove waste materials from Authority's property and legally dispose of them.

3.05 ATTACHMENTS

- A. Form CWM-1 for construction waste identification.
- B. Form CWM-3 for construction waste reduction work plan.
- C. Form CWM-5 cost/revenue analysis of construction waste reduction work plan.
- D. Form CWM-7 for construction waste

END OF SECTION 01 74 19

FORM CWM-1: CONSTRUCTION WASTE IDENTIFICATION

Material Category	Generation Point	Est. Quantity Of Materials Received* (A)	Est. Waste - % (B)	Total Est. Quantity Of Waste* (C = A X B)	Est. Volume Cy (Cm)	Est. Weight Tons (Tonnes)	Remarks And Assumptions
Packaging: Cardboard							
Packaging: Boxes							
Packaging: Plastic Sheet or Film							
Packaging: Polystyrene							
Packaging: Pallets or Skids							
Packaging: Crates							
Packaging: Paint Cans							
Packaging: Plastic Pails							
Site-Clearing Waste							
Masonry or CMU							
Lumber: Cut-Offs							
Lumber: Warped Pieces							
Plywood or OSB (scraps)							
Wood Forms							
Wood Waste Chutes							
Wood Trim (cut-offs)							
Metals							
Insulation							
Roofing							
Joint Sealant Tubes							
Gypsum Board (scraps)							
Carpet and Pad (scraps)							
Piping							
Electrical Conduit							
Other:							

* Insert units of measure.

FORM CWM-3: CONSTRUCTION WASTE REDUCTION WORK PLAN

Material Category	Generation Point	Total Est. Quantity Of Waste Tons (Tonnes)	Disposal Method And Quantity			Handling And Transportation Procedures
			Est. Amount Salvaged Tons (Tonnes)	Est. Amount Recycled Tons (Tonnes)	Est. Amount Disposed To Landfill Tons (Tonnes)	
Packaging: Cardboard						
Packaging: Boxes						
Packaging: Plastic Sheet or Film						
Packaging: Polystyrene						
Packaging: Pallets or Skids						
Packaging: Crates						
Packaging: Paint Cans						
Packaging: Plastic Pails						
Site-Clearing Waste						
Masonry or CMU						
Lumber: Cut-Offs						
Lumber: Warped Pieces						
Plywood or OSB (scraps)						
Wood Forms						
Wood Waste Chutes						
Wood Trim (cut-offs)						
Metals						
Insulation						
Roofing						
Joint Sealant Tubes						
Gypsum Board (scraps)						
Carpet and Pad (scraps)						
Piping						
Electrical Conduit						
Other:						

FORM CWM-5: COST/REVENUE ANALYSIS OF CONSTRUCTION WASTE REDUCTION WORK PLAN

Materials	Total Quantity Of Materials (Vol. Or Weight) (A)	Est. Cost Of Disposal (B)	Total Est. Cost Of Disposal (C = A X B)	Revenue From Salvaged Materials (D)	Revenue From Recycled Materials (E)	Landfill Tipping Fees Avoided (F)	Handling And Transportation Costs Avoided (G)	Net Cost Savings Of Work Plan (H = D+E+F+G)
Packaging: Cardboard								
Packaging: Boxes								
Packaging: Plastic Sheet or Film								
Packaging: Polystyrene								
Packaging: Pallets or Skids								
Packaging: Crates								
Packaging: Paint Cans								
Packaging: Plastic Pails								
Site-Clearing Waste								
Masonry or CMU								
Lumber: Cut-Offs								
Lumber: Warped Pieces								
Plywood or OSB (scraps)								
Wood Forms								
Wood Waste Chutes								
Wood Trim (cut-offs)								
Metals								
Insulation								
Roofing								
Joint Sealant Tubes								
Gypsum Board (scraps)								
Carpet and Pad (scraps)								
Piping								
Electrical Conduit								
Other:								

FORM CWM-7: CONSTRUCTION WASTE REDUCTION PROGRESS REPORT

Material Category	Generation Point	Total Quantity Of Waste Tons (Tonnes) (A)	Quantity Of Waste Salvaged		Quantity Of Waste Recycled		Total Quantity Of Waste Recovered Tons (Tonnes) (D = B + C)	Total Quantity Of Waste Recovered % (D / A X 100)
			Estimated Tons (Tonnes)	Actual Tons (Tonnes) (B)	Estimated Tons (Tonnes)	Actual TONS (TONNES) (C)		
Packaging: Cardboard								
Packaging: Boxes								
Packaging: Plastic Sheet or Film								
Packaging: Polystyrene								
Packaging: Pallets or Skids								
Packaging: Crates								
Packaging: Paint Cans								
Packaging: Plastic Pails								
Site-Clearing Waste								
Masonry or CMU								
Lumber: Cut-Offs								
Lumber: Warped Pieces								
Plywood or OSB (scraps)								
Wood Forms								
Wood Waste Chutes								
Wood Trim (cut-offs)								
Metals								
Insulation								
Roofing								
Joint Sealant Tubes								
Gypsum Board (scraps)								
Carpet and Pad (scraps)								
Piping								
Electrical Conduit								
Other:								

SECTION 01 77 00

CLOSEOUT PROCEDURES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section includes administrative and procedural requirements for contract closeout, including, but not limited to, the following:
 - 1. Substantial Completion procedures.
 - 2. Final completion procedures.
 - 3. Warranties.
 - 4. Project Record Documents.
 - 5. Operation and maintenance manuals.
 - 6. Final cleaning.
 - 7. Repair of the Work.
- B. Related Requirements:
 - 1. Section 01 32 00 "Construction Progress Documentation" for submitting final completion construction photographic documentation.
 - 2. Section 01 73 00 "Execution" for progress cleaning of Project site.

1.03 ACTION SUBMITTALS

- A. Product Data: For cleaning agents.
- B. Contractor's List of Incomplete Items: Initial submittal at Substantial Completion.
- C. Certified List of Incomplete Items: Final submittal at Final Completion.

1.04 CLOSEOUT SUBMITTALS

- A. Certificates of Release: From authorities having jurisdiction.
- B. Certificate of Insurance: For continuing coverage.
- C. Field Report: For pest control inspection.

1.05 MAINTENANCE MATERIAL SUBMITTALS

- A. Schedule of Maintenance Material Items: For maintenance material submittal items specified in other Sections.

1.06 SUBSTANTIAL COMPLETION PROCEDURES

- A. Contractor's List of Incomplete Items: Prepare and submit a list of items to be completed and corrected (Contractor's punch list), indicating the value of each item on the list and reasons why the Work is incomplete.

- B. Submittals Prior to Substantial Completion: Complete the following a minimum of 10 days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.
1. Certificates of Release: Obtain and submit releases from authorities having jurisdiction permitting Owner unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
 2. Submit closeout submittals specified in other Division 01 Sections, including project record documents, operation and maintenance manuals, final completion construction photographic documentation, damage or settlement surveys, property surveys, and similar final record information.
 3. Submit closeout submittals specified in individual Sections, including specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.
 4. Submit maintenance material submittals specified in individual Sections, including tools, spare parts, extra materials, and similar items, and deliver to location designated by Architect. Label with manufacturer's name and model number where applicable.
 - a. Schedule of Maintenance Material Items: Prepare and submit schedule of maintenance material submittal items, including name and quantity of each item and name and number of related Specification Section. Obtain Architect's signature for receipt of submittals.
 5. Submit test/adjust/balance records.
 6. Submit sustainable design submittals required in Section 01 81 13 "Sustainable Design Requirements," and in individual Sections.
 7. Submit changeover information related to Owner's occupancy, use, operation, and maintenance.
- C. Procedures Prior to Substantial Completion: Complete the following a minimum of 10 days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.
1. Advise Owner of pending insurance changeover requirements.
 2. Make final changeover of permanent locks and deliver keys to Owner. Advise Owner's personnel of changeover in security provisions.
 3. Complete startup and testing of systems and equipment.
 4. Perform preventive maintenance on equipment used prior to Substantial Completion.
 5. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems. Submit demonstration and training video recordings.
 6. Advise Owner of changeover in heat and other utilities.
 7. Participate with Owner in conducting inspection and walkthrough with local emergency responders.
 8. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.
 9. Complete final cleaning requirements, including touchup painting.
 10. Touch up and otherwise repair and restore marred exposed finishes to eliminate visual defects.
- D. Inspection: Submit a written request for inspection to determine Substantial Completion a minimum of 10 days prior to date the work will be completed and ready for final inspection and tests. On receipt of request, Architect will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will prepare the Certificate of Substantial Completion after inspection or will notify Contractor of items,

either on Contractor's list or additional items identified by Architect, that must be completed or corrected before certificate will be issued.

1. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.
2. Results of completed inspection will form the basis of requirements for final completion.

1.07 FINAL COMPLETION PROCEDURES

- A. Submittals Prior to Final Completion: Before requesting final inspection for determining final completion, complete the following:
 1. Submit a final Application for Payment according to Section 01 29 00 "Payment Procedures."
 2. Certified List of Incomplete Items: Submit certified copy of Architect's Substantial Completion inspection list of items to be completed or corrected (punch list), endorsed and dated by Architect. Certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance.
 3. Certificate of Insurance: Submit evidence of final, continuing insurance coverage complying with insurance requirements.
 4. Submit pest-control final inspection report.
- B. Inspection: Submit a written request for final inspection to determine acceptance a minimum of 10 days prior to date the work will be completed and ready for final inspection and tests. On receipt of request, Architect will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will prepare a final Certificate for Payment after inspection or will notify Contractor of construction that must be completed or corrected before certificate will be issued.
 1. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.

1.08 LIST OF INCOMPLETE ITEMS (PUNCH LIST)

- A. Organization of List: Include name and identification of each space and area affected by construction operations for incomplete items and items needing correction including, if necessary, areas disturbed by Contractor that are outside the limits of construction.
 1. Organize list of spaces in sequential order, starting with exterior areas first and proceeding from lowest floor to highest floor.
 2. Organize items applying to each space by major element, including categories for ceiling, individual walls, floors, equipment, and building systems.
 3. Include the following information at the top of each page:
 - a. Project name.
 - b. Date.
 - c. Name of Architect.
 - d. Name of Contractor.
 - e. Page number.
 4. Submit list of incomplete items in the following format:
 - a. MS Excel electronic file. Architect will return annotated file.
 - b. PDF electronic file. Architect will return annotated file.

1.09 PROJECT RECORD DOCUMENTS

-
- A. General: Do not use Project Record Documents for construction purposes. Protect Project Record Documents from deterioration and loss. Provide access to Project Record Documents for Architect's reference during normal working hours.
- B. Record Drawings: Maintain and submit one set of blue- or black-line white prints of Contract Drawings and Shop Drawings.
1. Mark Record Prints to show the actual installation where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to prepare the marked-up Record Prints.
 - a. Give particular attention to information on concealed elements that cannot be readily identified and recorded later.
 - b. Accurately record information in an understandable drawing technique.
 - c. Record data as soon as possible after obtaining it. Record and check the markup before enclosing concealed installations.
 - d. Mark Contract Drawings or Shop Drawings, whichever is most capable of showing actual physical conditions, completely and accurately. Where Shop Drawings are marked, show cross-reference on Contract Drawings.
 2. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at the same location.
 3. Mark important additional information that was either shown schematically or omitted from original Drawings.
 4. Note Construction Change Directive numbers, Change Order numbers, alternate numbers, and similar identification where applicable.
 5. Identify and date each Record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location. Organize into manageable sets; bind each set with durable paper cover sheets. Include identification on cover sheets.
- C. Record Specifications: Submit one copy of Project's Specifications, including addenda and contract modifications. Mark copy to indicate the actual product installation where installation varies from that indicated in Specifications, addenda, and contract modifications.
1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
 2. Mark copy with the proprietary name and model number of products, materials, and equipment furnished, including substitutions and product options selected.
 3. Note related Change Orders, Record Drawings[, and Product Data], where applicable.
- D. Record Product Data: Submit one copy of each Product Data submittal. Mark one set to indicate the actual product installation where installation varies substantially from that indicated in Product Data.
1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
 2. Include significant changes in the product delivered to Project site and changes in manufacturer's written instructions for installation.
 3. Note related Change Orders, Record Drawings[, and Record Specifications], where applicable.

- E. Miscellaneous Record Submittals: Assemble miscellaneous records required by other Specification Sections for miscellaneous record keeping and submittal in connection with actual performance of the Work. Bind or file miscellaneous records and identify each, ready for continued use and reference.

1.10 OPERATION AND MAINTENANCE MANUALS

- A. Assemble a complete set of operation and maintenance data indicating the operation and maintenance of each system, subsystem, and piece of equipment not part of a system. Include operation and maintenance data required in individual Specification Sections and as follows:
1. Operation Data:
 - a. Emergency instructions and procedures.
 - b. System, subsystem, and equipment descriptions, including operating standards.
 - c. Operating procedures, including startup, shutdown, seasonal, and weekend operations.
 - d. Description of controls and sequence of operations.
 - e. Piping diagrams.
 2. Maintenance Data:
 - a. Manufacturer's information, including list of spare parts.
 - b. Name, address, and telephone number of Installer or supplier.
 - c. Maintenance procedures.
 - d. Maintenance and service schedules for preventive and routine maintenance.
 - e. Maintenance record forms.
 - f. Sources of spare parts and maintenance materials.
 - g. Copies of maintenance service agreements.
 - h. Copies of warranties and bonds.
- B. Organize operation and maintenance manuals into suitable sets of manageable size. Bind and index data in heavy-duty, 3-ring, vinyl-covered, loose-leaf binders, in thickness necessary to accommodate contents, with pocket inside the covers to receive folded oversized sheets. Identify each binder on front and spine with the printed title "OPERATION AND MAINTENANCE MANUAL," Project name, and subject matter of contents.

1.11 SUBMITTAL OF PROJECT WARRANTIES

- A. Time of Submittal: Submit written warranties on request of Architect for designated portions of the Work where commencement of warranties other than date of Substantial Completion is indicated, or when delay in submittal of warranties might limit Owner's rights under warranty.
- B. Partial Occupancy: Submit properly executed warranties within **[15]** **◀Insert number▶** days of completion of designated portions of the Work that are completed and occupied or used by Owner during construction period by separate agreement with Contractor.
- C. Organize warranty documents into an orderly sequence based on the table of contents of Project Manual.
1. Bind warranties and bonds in heavy-duty, three-ring, vinyl-covered, loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2-by-11-inch paper.

2. Provide heavy paper dividers with plastic-covered tabs for each separate warranty. Mark tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product and the name, address, and telephone number of Installer.
 3. Identify each binder on the front and spine with the typed or printed title "WARRANTIES," Project name, and name of Contractor.
 4. Warranty Electronic File: Scan warranties and bonds and assemble complete warranty and bond submittal package into a single indexed electronic PDF file with links enabling navigation to each item. Provide bookmarked table of contents at beginning of document.
- D. Provide additional copies of each warranty to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.
1. Use cleaning products that comply with Green Seal's GS-37, or if GS-37 is not applicable, use products that comply with the California Code of Regulations maximum allowable VOC levels.

PART 3 - EXECUTION

3.01 DEMONSTRATION AND TRAINING

- A. Instruction: Instruct Owner's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.
1. Provide instructors experienced in operation and maintenance procedures.
 2. Provide instruction at mutually agreed-on times. For equipment that requires seasonal operation, provide similar instruction at the start of each season.
 3. Schedule training with Owner, through Architect with at least seven days' advance notice.
 4. Coordinate instructors, including providing notification of dates, times, length of instruction, and course content.
- B. Program Structure: Develop an instruction program that includes individual training modules for each system and equipment not part of a system, as required by individual Specification Sections. For each training module, develop a learning objective and teaching outline. Include instruction for the following:
1. System design and operational philosophy.
 2. Review of documentation.
 3. Operations.
 4. Adjustments.
 5. Troubleshooting.
 6. Maintenance.
 7. Repair.

3.02 FINAL CLEANING

- A. General: Perform final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.
- B. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to condition expected in an average commercial building cleaning and maintenance program. Comply with manufacturer's written instructions.
 - 1. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for entire Project or for a designated portion of Project:
 - a. Clean Project site, yard, and grounds, in areas disturbed by construction activities, including landscape development areas, of rubbish, waste material, litter, and other foreign substances.
 - b. Sweep paved areas broom clean. Remove petrochemical spills, stains, and other foreign deposits.
 - c. Rake grounds that are neither planted nor paved to a smooth, even-textured surface.
 - d. Remove tools, construction equipment, machinery, and surplus material from Project site.
 - e. Remove snow and ice to provide safe access to building.
 - f. Clean exposed exterior and interior hard-surfaced finishes to a dirt-free condition, free of stains, films, and similar foreign substances. Avoid disturbing natural weathering of exterior surfaces. Restore reflective surfaces to their original condition.
 - g. Remove debris and surface dust from limited access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.
 - h. Sweep concrete floors broom clean in unoccupied spaces.
 - i. Vacuum carpet and similar soft surfaces, removing debris and excess nap; clean according to manufacturer's recommendations if visible soil or stains remain.
 - j. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compounds and other noticeable, vision-obscuring materials. Polish mirrors and glass, taking care not to scratch surfaces.
 - k. Remove labels that are not permanent.
 - l. Wipe surfaces of mechanical and electrical equipment, elevator equipment, and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
 - m. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.
 - n. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.
 - o. Clean ducts, blowers, and coils if units were operated without filters during construction or that display contamination with particulate matter on inspection.
 - 1) Clean HVAC system in compliance with NADCA Standard 1992-01. Provide written report on completion of cleaning.
 - p. Clean light fixtures, lamps, globes, and reflectors to function with full efficiency.
 - q. Leave Project clean and ready for occupancy.

- C. Pest Control: Comply with pest control requirements in Section 01 50 00 "Temporary Facilities and Controls." Prepare written report.
- D. Construction Waste Disposal: Comply with waste disposal requirements in Section 01 74 19 "Construction Waste Management and Disposal."

3.03 REPAIR OF THE WORK

- A. Complete repair and restoration operations before requesting inspection for determination of Substantial Completion.
- B. Repair or remove and replace defective construction. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment. Where damaged or worn items cannot be repaired or restored, provide replacements. Remove and replace operating components that cannot be repaired. Restore damaged construction and permanent facilities used during construction to specified condition.
 - 1. Remove and replace chipped, scratched, and broken glass, reflective surfaces, and other damaged transparent materials.
 - 2. Touch up and otherwise repair and restore marred or exposed finishes and surfaces. Replace finishes and surfaces that already show evidence of repair or restoration.
 - a. Do not paint over "UL" and other required labels and identification, including mechanical and electrical nameplates. Remove paint applied to required labels and identification.
 - 3. Replace parts subject to operating conditions during construction that may impede operation or reduce longevity.
 - 4. Replace burned-out bulbs, bulbs noticeably dimmed by hours of use, and defective and noisy starters in fluorescent and mercury vapor fixtures to comply with requirements for new fixtures.

END OF SECTION 01 77 00

SECTION 01 78 39
PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Requirements for as-built drawings.

1.2 SUBMITTALS

- A. Procedures: Section 01 33 00, Submittal Procedures.
- B. Incremental Submission of As-Built Drawings
1. Upon request from the Engineer, make available copies of selected as-built drawings in color.
 2. Incremental as-built drawings requested by the Engineer shall be stamped "As-Built", signed, and dated by Contractor.
- C. Final Submission of As-Built Drawings:
1. At completion of Work, and before requesting Final Acceptance of Work, deliver Final as-built drawings to the Engineer.
 2. Stamp drawings "As-Built Record."
 3. Submit five hard copies and three electronic copies on CD or DVD in AutoCAD (latest version) and in PDF formats.
 4. Submit as-built drawings and include the following information:
 - a. Date of submission.
 - b. Project title and number.
 - c. Contractor's name and address.
 - d. Certification that as-built drawings as submitted are complete and accurate.
 - e. Signature of Contractor or its authorized representative.

PART 2 - PRODUCTS

Not Used

PART 3 - EXECUTION

3.1 MAINTENANCE OF AS-BUILT DRAWINGS

- A. During factory wiring and testing of a TPSS, or other equipment, immediately update drawings or documents affected by a change in the circuits or equipment.
- B. During on-site installation and testing, maintain in each TPSS plan books of approved shop drawings, and immediately update drawings affected by a change in the circuits or equipment.
- C. Protect drawings from damage.
- D. Update as-built documents continuously during the course of construction.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

Not Used

4.2 PAYMENT

Not Used

END OF SECTION

SECTION 01 81 13**SUSTAINABLE DESIGN REQUIREMENTS****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section includes general requirements and procedures for compliance with certain USGBC LEED prerequisites and credits needed for Project to obtain LEED-Gold-certification based on USGBC's "LEED 2009 for New Construction & Major Renovations."
 - 1. Other LEED prerequisites and credits needed to obtain LEED certification depend on product selections and may not be specifically identified as LEED requirements. Compliance with requirements needed to obtain LEED prerequisites and credits may be used as one criterion to evaluate substitution requests and comparable product requests.
 - 2. Additional LEED prerequisites and credits needed to obtain the indicated LEED certification depend on Architect's design and other aspects of Project that are not part of the Work of the Contract.
 - 3. A copy of the LEED Project checklist is attached at the end of this Section for information only.
 - 4. Specific requirements for LEED are included in greater detail in other Sections.

1.03 DEFINITIONS

- A. Chain-of-Custody Certificates: Certificates signed by manufacturers certifying that wood used to make products was obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship." Certificates shall include evidence that manufacturer is certified for chain of custody by an FSC-accredited certification body.
- B. Regional Materials: Materials that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles of Project site. If only a fraction of a product or material is extracted/harvested/recovered and manufactured locally, then only that percentage (by weight) shall contribute to the regional value.
- C. Recycled Content: The recycled content value of a material assembly shall be determined by weight. The recycled fraction of the assembly is then multiplied by the cost of assembly to determine the recycled content value.
 - 1. "Post-consumer" material is defined as waste material generated by households or by commercial, industrial, and institutional facilities in their role as end users of the product, which can no longer be used for its intended purpose.
 - 2. "Pre-consumer" material is defined as material diverted from the waste stream during the manufacturing process. Excluded is reutilization of materials such as rework, regrind, or scrap generated in a process and capable of being reclaimed within the same process that generated it.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Respond to questions and requests from Architect and the USGBC regarding LEED credits that are the responsibility of the Contractor, that depend on product selection or product qualities, or that depend on Contractor's procedures until the USGBC has made its determination on the project's LEED certification application. Document responses as informational submittals.

1.05 ACTION SUBMITTALS

- A. General: Submit additional LEED submittals required by other Specification Sections.
- B. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.
- C. LEED Documentation Submittals:
1. Credit EA 5: Product data and wiring diagrams for sensors and data collection system used to provide continuous metering of building energy-consumption performance over a period of time of not less than one year of postconstruction occupancy.
 2. Credit MR 2: Comply with Section 01 74 19 "Construction Waste Management and Disposal."
 3. Credit MR 4: Product data and certification letter from product manufacturers indicating percentages by weight of post-consumer and pre-consumer recycled content for products having recycled content. Include statement indicating material cost for each product having recycled content.
 4. Credit MR 5: Product data for regional materials indicating location and distance from Project of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include statement indicating cost for each regional material and the fraction by weight that is considered regional.
 5. Credit MR 7: Product data and chain-of-custody certificates for products containing certified wood. Include statement indicating cost for each certified wood product.
 6. Credit IEQ 3.1:
 - a. Construction indoor-air-quality management plan.
 - b. Product data for temporary filtration media.
 - c. Product data for filtration media used during occupancy.
 - d. Construction Documentation: Six photographs at three different times during the construction period, along with a brief description of the SMACNA approach employed, documenting implementation of the indoor-air-quality management measures, such as protection of ducts and on-site stored or installed absorptive materials.
 7. Credit IEQ 3.2:
 - a. Signed statement describing the building air flush-out procedures including the dates when flush-out was begun and completed and statement that filtration media was replaced after flush-out.
 - b. Product data for filtration media used during flush-out and during occupancy.
 - c. Report from testing and inspecting agency indicating results of indoor-air-quality testing and documentation showing compliance with indoor-air-quality testing procedures and requirements.
 8. Credit IEQ 4.1: Product data for adhesives and sealants used inside the weatherproofing system indicating VOC content of each product used.
 9. Credit IEQ 4.2: Product data for paints and coatings used inside the weatherproofing system indicating VOC content of each product used.

10. Credit IEQ 4.4: Product data for products containing composite wood or agrifiber products or wood glues indicating that they do not contain urea-formaldehyde resin.

1.06 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For LEED coordinator.
- B. Project Materials Cost Data: Provide statement indicating total cost for materials used for Project. Costs exclude labor, overhead, and profit. Include breakout of costs for the following categories of items:
 1. Furniture.
 2. Plumbing.
 3. Mechanical.
 4. Electrical.
 5. Specialty items such as elevators and equipment.
 6. Wood-based construction materials.
- C. LEED Action Plans: Provide preliminary submittals within seven days of date established for the Notice to Proceed indicating how the following requirements will be met:
 1. Credit MR 2: Waste management plan complying with Section 01 74 19 "Construction Waste Management and Disposal."
 2. Credit MR 4: List of proposed materials with recycled content. Indicate cost, post-consumer recycled content, and pre-consumer recycled content for each product having recycled content.
 3. Credit MR 5: List of proposed regional materials. Identify each regional material, including its source, cost, and the fraction by weight that is considered regional.
 4. Credit MR 7: List of proposed certified wood products. Indicate each product containing certified wood, including its source and cost of certified wood products.
 5. Credit IEQ 3.1: Construction indoor-air-quality management plan.
- D. LEED Progress Reports: Concurrent with each Application for Payment, submit reports comparing actual construction and purchasing activities with LEED action plans for the following:
 1. Credit MR 2: Waste reduction progress reports complying with Section 01 74 19 "Construction Waste Management and Disposal."
 2. Credit MR 4: Recycled content.
 3. Credit MR 5: Regional materials.
 4. Credit MR 7: Certified wood products.

1.07 QUALITY ASSURANCE

- A. LEED Coordinator: Engage an experienced LEED-Accredited Professional to coordinate LEED requirements. LEED coordinator may also serve as waste management coordinator.

PART 2 - PRODUCTS

2.01 MATERIALS, GENERAL

- A. Provide products and procedures necessary to obtain LEED credits required in this Section. Although other Sections may specify some requirements that contribute to

LEED credits, the Contractor shall determine additional materials and procedures necessary to obtain LEED credits indicated.

2.02 RECYCLED CONTENT OF MATERIALS

- A. Credit MR 4: Building materials shall have recycled content such that post-consumer recycled content plus one-half of pre-consumer recycled content for Project constitutes a minimum of 20 percent of cost of materials used for Project.
1. Cost of post-consumer recycled content plus one-half of pre-consumer recycled content of an item shall be determined by dividing weight of post-consumer recycled content plus one-half of pre-consumer recycled content in the item by total weight of the item and multiplying by cost of the item.
 2. Do not include furniture, plumbing, mechanical and electrical components, and specialty items such as elevators and equipment in the calculation.

2.03 REGIONAL MATERIALS

- A. Credit MR 5: Not less than 20 percent of building materials (by cost) shall be regional materials.

2.04 CERTIFIED WOOD

- A. Credit MR 7: Not less than 50 percent (by cost) of wood-based materials shall be produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."
1. Wood-based materials include, but are not limited to, the following materials when made from wood, engineered wood products, or wood-based panel products:
 - a. Rough carpentry.
 - b. Miscellaneous carpentry.
 - c. Finish carpentry.
 - d. Architectural woodwork.
 - e. Wood paneling.
 - f. Wood veneer wall covering.
 - g. Wood flooring.
 - h. Wood lockers.
 - i. Wood cabinets.

2.05 LOW-EMITTING MATERIALS

- A. Credit IEQ 4.1: For field applications that are inside the weatherproofing system, adhesives and sealants shall comply with the following VOC content limits when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
1. Wood Glues: 30 g/L.
 2. Metal-to-Metal Adhesives: 30 g/L.
 3. Adhesives for Porous Materials (Except Wood): 50 g/L.
 4. Subfloor Adhesives: 50 g/L.
 5. Plastic Foam Adhesives: 50 g/L.
 6. Carpet Adhesives: 50 g/L.
 7. Carpet Pad Adhesives: 50 g/L.
 8. VCT and Asphalt Tile Adhesives: 50 g/L.
 9. Cove Base Adhesives: 50 g/L.
 10. Gypsum Board and Panel Adhesives: 50 g/L.

11. Rubber Floor Adhesives: 60 g/L.
 12. Ceramic Tile Adhesives: 65 g/L.
 13. Multipurpose Construction Adhesives: 70 g/L.
 14. Fiberglass Adhesives: 80 g/L.
 15. Contact Adhesive: 80 g/L.
 16. Structural Glazing Adhesives: 100 g/L.
 17. Wood Flooring Adhesive: 100 g/L.
 18. Structural Wood Member Adhesive: 140 g/L.
 19. Single-Ply Roof Membrane Adhesive: 250 g/L.
 20. Special-Purpose Contact Adhesive (contact adhesive that is used to bond melamine-covered board, metal, unsupported vinyl, rubber, or wood veneer 1/16 inch or less in thickness to any surface): 250 g/L.
 21. Top and Trim Adhesive: 250 g/L.
 22. Plastic Cement Welding Compounds: 250 g/L.
 23. ABS Welding Compounds: 325 g/L.
 24. CPVC Welding Compounds: 490 g/L.
 25. PVC Welding Compounds: 510 g/L.
 26. Adhesive Primer for Plastic: 550 g/L.
 27. Sheet-Applied Rubber Lining Adhesive: 850 g/L.
 28. Aerosol Adhesive, General-Purpose Mist Spray: 65 percent by weight.
 29. Aerosol Adhesive, General-Purpose Web Spray: 55 percent by weight.
 30. Special-Purpose Aerosol Adhesive (All Types): 70 percent by weight.
 31. Other Adhesives: 250 g/L.
 32. Architectural Sealants: 250 g/L.
 33. Nonmembrane Roof Sealants: 300 g/L.
 34. Single-Ply Roof Membrane Sealants: 450 g/L.
 35. Other Sealants: 420 g/L.
 36. Sealant Primers for Nonporous Substrates: 250 g/L.
 37. Sealant Primers for Porous Substrates: 775 g/L.
 38. Modified Bituminous Sealant Primers: 500 g/L.
 39. Other Sealant Primers: 750 g/L.
- B. Credit IEQ 4.2: For field applications that are inside the weatherproofing system, paints and coatings shall comply with the following VOC content limits when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
1. Flat Paints and Coatings: VOC not more than 50 g/L.
 2. Nonflat Paints and Coatings: VOC not more than 150 g/L.
 3. Dry-Fog Coatings: VOC not more than 400 g/L.
 4. Primers, Sealers, and Undercoaters: VOC not more than 200 g/L.
 5. Anticorrosive and Antirust Paints Applied to Ferrous Metals: VOC not more than 250 g/L.
 6. Zinc-Rich Industrial Maintenance Primers: VOC not more than 340 g/L.
 7. Pretreatment Wash Primers: VOC not more than 420 g/L.
 8. Clear Wood Finishes, Varnishes: VOC not more than 350 g/L.
 9. Clear Wood Finishes, Lacquers: VOC not more than 550 g/L.
 10. Floor Coatings: VOC not more than 100 g/L.
 11. Shellacs, Clear: VOC not more than 730 g/L.
 12. Shellacs, Pigmented: VOC not more than 550 g/L.
 13. Stains: VOC not more than 250 g/L.
- C. Credit IEQ 4.4: Composite wood, agrifiber products, and adhesives shall not contain urea-formaldehyde resin.

PART 3 - EXECUTION

3.01 MEASUREMENT AND VERIFICATION

- A. Credit EA 5: Implement measurement and verification plan consistent with [Option B: Energy Conservation Measure Isolation] [Option D: Calibrated Simulation, Savings Estimation Method 2] in the EVO's "International Performance Measurement and Verification Protocol (IPMVP), Volume III: Concepts and Options for Determining Energy Savings in New Construction," and as further defined by the following:
1. [Insert measurement and verification plan design team submitted for credit].
- B. If not already in place, install metering equipment to measure energy usage. Monitor, record, and trend log measurements.
- C. Evaluate energy performance and efficiency by comparing actual to predicted performance.
- D. Measurement and verification period shall cover at least one year of postconstruction occupancy.

3.02 CONSTRUCTION WASTE MANAGEMENT

- A. Credit MR 2: Comply with Section 01 74 19 "Construction Waste Management and Disposal."

3.03 CONSTRUCTION INDOOR-AIR-QUALITY MANAGEMENT

- A. Credit IEQ 3.1: Comply with SMACNA's "SMACNA IAQ Guideline for Occupied Buildings under Construction."
1. If Owner authorizes use of permanent heating, cooling, and ventilating systems during construction period as specified in Section 01 50 00 "Temporary Facilities and Controls," install filter media having a MERV 8 according to ASHRAE 52.2 at each return-air inlet for the air-handling system used during construction.
 2. Replace all air filters immediately prior to occupancy.
- B. Credit IEQ 3.2: Comply with one of the following requirements:
1. After construction ends, prior to occupancy and with all interior finishes installed, perform a building flush-out by supplying a total volume of 14000 cu. ft. of outdoor air per sq. ft. of floor area while maintaining an internal temperature of at least 60 deg F and a relative humidity no higher than 60 percent.
 - a. [Insert operating requirements].
 2. If occupancy is desired prior to flush-out completion, the space may be occupied following delivery of a minimum of 3500 cu. ft. of outdoor air per sq. ft. of floor area to the space. Once a space is occupied, it shall be ventilated at a minimum rate of 0.30 cfm per sq. ft. of outside air or the design minimum outside air rate determined in Prerequisite IEQ 1, whichever is greater. During each day of the flush-out period, ventilation shall begin a minimum of three hours prior to occupancy and continue during occupancy. These conditions shall be maintained until a total of 14000 cu. ft./sq. ft. of outside air has been delivered to the space.
 - a. [Insert operating requirements].
 3. Air-Quality Testing:
 - a. Conduct baseline indoor-air-quality testing, after construction ends and prior to occupancy, using testing protocols consistent with the EPA's

"Compendium of Methods for the Determination of Air Pollutants in Indoor Air," and as additionally detailed in the USGBC's "Green Building Design and Construction Reference Guide."

- b. Demonstrate that the contaminant maximum concentrations listed below are not exceeded:
 - 1) Formaldehyde: 27 ppb.
 - 2) Particulates (PM10): 50 micrograms/cu. m.
 - 3) Total Volatile Organic Compounds (TVOC): 500 micrograms/cu. m.
 - 4) 4-Phenylcyclohexene (4-PH): 6.5 micrograms/cu. m.
 - 5) Carbon Monoxide: 9 ppm and no greater than 2 ppm above outdoor levels.
- c. For each sampling point where the maximum concentration limits are exceeded, conduct additional flush-out with outside air and retest the specific parameter(s) exceeded to indicate the requirements are achieved. Repeat procedure until all requirements have been met. When retesting noncomplying building areas, take samples from same locations as in the first test.
- d. Air-sample testing shall be conducted as follows:
 - 1) All measurements shall be conducted prior to occupancy but during normal occupied hours, and with building ventilation system starting at the normal daily start time and operated at the minimum outside air flow rate for the occupied mode throughout the duration of the air testing.
 - 2) Building shall have all interior finishes installed including, but not limited to, millwork, doors, paint, carpet, and acoustic tiles. Nonfixed furnishings such as workstations and partitions are encouraged, but not required, to be in place for the testing.
 - 3) Number of sampling locations varies depending on the size of building and number of ventilation systems. For each portion of building served by a separate ventilation system, the number of sampling points shall not be less than one per 25,000 sq. ft. or for each contiguous floor area, whichever is larger, and shall include areas with the least ventilation and greatest presumed source strength.
 - 4) Air samples shall be collected between 3 and 6 feet from the floor to represent the breathing zone of occupants, and over a minimum four-hour period.

END OF SECTION 01 81 13



LEED 2009 For New Construction and Major Renovations Project Checklist

Project Name: **Kansas City Street Car Maintenance Facility**

Project Address: **Kansas City, Missouri**

LEED Goal: **Gold**



Yes ? No
22 1 3 **Sustainable Sites** **26 Points**

Y										
				c	SSp1	Construction Activity Pollution Prevention				Required
1				d	SSc1	Site Selection				1
5				d	SSc2	Development Density & Community Connectivity				5
			1	d	SSc3	Brownfield Redevelopment				1
6				d	SSc4.1	Alternative Transportation, Public Transportation Access				6
1				d	SSc4.2	Alternative Transportation, Bicycle Storage and Changing Rooms				1
3				d	SSc4.3	Alternative Transportation, Low-Emitting and Fuel-Efficient Vehicles				3
2				d	SSc4.4	Alternative Transportation, Parking Capacity				2
			1	c	SSc5.1	Site Development, Protect or Restore Habitat				1
			1	d	SSc5.2	Site Development, Maximize Open Space				1
1				d	SSc6.1	Stormwater Design, Quantity Control				1
1				d	SSc6.2	Stormwater Design, Quality Control				1
1				c	SSc7.1	Heat Island Effect, Non-Roof				1
1				d	SSc7.2	Heat Island Effect, Roof				1
	1			d	SSc8	Light Pollution Reduction				1



Yes ? No
6 0 4 **Water Efficiency** **10 Points**

Y				d	WEp1	Water Use Reduction				Required
2			2	d	WEc1	Water Efficient Landscaping				2 to 4
						2 Reduce by 50%				2
						No Potable Water Use or Irrigation				4
			2	d	WEc2	Innovative Wastewater Technologies				2
4				d	WEc3	Water Use Reduction				2 to 4
						30% Reduction				2
						35% Reduction				3
						40% Reduction				4



Yes ? No
12 14 9 **Energy & Atmosphere** **35 Points**

Y				c	EAp1	Fundamental Commissioning of the Building Energy Systems				Required
Y				d	EAp2	Minimum Energy Performance				Required
Y				d	EAp3	Fundamental Refrigerant Management				Required
10	2	7		d	EAc1	Optimize Energy Performance				1 to 19
						12% New Buildings or 8% Existing Building Renovations				1
						14% New Buildings or 10% Existing Building Renovations				2
						16% New Buildings or 12% Existing Building Renovations				3
						18% New Buildings or 14% Existing Building Renovations				4
						20% New Buildings or 16% Existing Building Renovations				5

					22% New Buildings or 18% Existing Building Renovations	6
					24% New Buildings or 20% Existing Building Renovations	7
					26% New Buildings or 22% Existing Building Renovations	8
					28% New Buildings or 24% Existing Building Renovations	9
				10	30% New Buildings or 26% Existing Building Renovations	10
					32% New Buildings or 28% Existing Building Renovations	11
					34% New Buildings or 30% Existing Building Renovations	12
					36% New Buildings or 32% Existing Building Renovations	13
					38% New Buildings or 34% Existing Building Renovations	14
					40% New Buildings or 36% Existing Building Renovations	15
					42% New Buildings or 38% Existing Building Renovations	16
					44% New Buildings or 40% Existing Building Renovations	17
					46% New Buildings or 42% Existing Building Renovations	18
					48% New Buildings or 44% Existing Building Renovations	19
	7			d	On-Site Renewable Energy	1 to 7
					1% Renewable Energy	1
					3% Renewable Energy	2
					5% Renewable Energy	3
					7% Renewable Energy	4
					9% Renewable Energy	5
					11% Renewable Energy	6
					13% Renewable Energy	7
	2			c	Enhanced Commissioning	2
			2	d	Enhanced Refrigerant Management	2
		3		c	Measurement & Verification	3
		2		c	Green Power	2



Yes ? No
7 0 4 **Materials & Resources** **14 Points**

Y				d	MRp1 Storage & Collection of Recyclables	Required
			1	c	MRc1.1 Building Reuse, Maintain Existing Walls, Floors & Roof	1 to 3
					Reuse 55%	1
					Reuse 75%	2
					Reuse 95%	3
			1	c	MRc1.2 Building Reuse, Maintain Interior Nonstructural Elements	1
	2			c	MRc2 Construction Waste Management	1 to 2
					50% Recycled or Salvaged	1
				2	75% Recycled or Salvaged	2
			1	c	MRc3 Materials Reuse	1 to 2
					Reuse 5%	1
					Reuse 10%	2
	2			c	MRc4 Recycled Content	1 to 2
					10% of Content	1
				2	20% of Content	2
	2			c	MRc5 Regional Materials	1 to 2
					10% of Materials	1
				2	20% of Materials	2
			1	c	MRc6 Rapidly Renewable Materials	1
	1			c	MRc7 Certified Wood	1



Yes ? No
13 2 0 **Indoor Environmental Quality** **15 Points**

Y				d	EQp1 Minimum IAQ Performance	Required
Y				d	EQp2 Environmental Tobacco Smoke (ETS) Control	Required
	1			d	EQc1 Outdoor Air Delivery Monitoring	1
	1			d	EQc2 Increased Ventilation	1

1				c	EQc3.1 Construction IAQ Management Plan , During Construction	1
1				c	EQc3.2 Construction IAQ Management Plan , Before Occupancy	1
1				c	EQc4.1 Low-Emitting Materials , Adhesives and Sealants	1
1				c	EQc4.2 Low-Emitting Materials , Paints and Coatings	1
1				c	EQc4.3 Low-Emitting Materials , Flooring Systems	1
1				c	EQc4.4 Low-Emitting Materials , Composite Wood and Agrifiber Products	1
	1			d	EQc5 Indoor Chemical & Pollutant Source Control	1
1				d	EQc6.1 Controllability of Systems , Lighting	1
1				d	EQc6.2 Controllability of Systems , Thermal Comfort	1
1				d	EQc7.1 Thermal Comfort , Design	1
1				d	EQc7.2 Thermal Comfort , Verification	1
1				d	EQc8.1 Daylight & Views , Daylight 75% of Spaces	1
	1			d	EQc8.2 Daylight & Views , Views for 90% of Spaces	1



Yes	?	No				
3	3	0	Innovation in Design			6 Points

	1			d	IDc1.1 Exemplary Performance: SSc6.2	1
1				d	IDc1.2 Innovation or Exemplary Performance: MRpc69 - Construction and Demolition	1
	1			d	IDc1.3 Innovation or Exemplary Performance: Process Water Use Reduction	1
	1			d	IDc1.4 Exemplary Performance: Green Power	1
1				d	IDc1.5 Innovation: Green Education	1
1				c	IDc2 LEED® Accredited Professional	1



Yes	?	No				
4	0	0	Regional Priority			4 Points

1				d	RPc1.1 Regional Priority: MRc2 - Construction Waste Mgmt 75%	1
1				d	RPc1.2 Regional Priority: SSc2 Development Density	1
1				d	RPc1.3 Regional Priority: SSc7.2 Heat Island Effect - Roof	1
1				d	RPc1.4 Regional Priority: WEc3 30%	1

Yes	?	No				
67	20	20	Project Totals (pre-certification estimates)			110 Points

Certified 40-49 points Silver 50-59 points Gold 60-79 points Platinum 80 points and above

SECTION 01 91 13**GENERAL COMMISSIONING REQUIREMENTS**

PART 1 GENERAL

1.01 DESCRIPTION

- A. The work described in this section includes the formal and comprehensive commissioning process and responsibilities of the Owner, CxA (Owner selected Commissioning Authority), General Contractor and subcontractors / vendors. These participants shall work together as a Commissioning Team to complete all commissioning requirements:
1. A Commissioning Authority (CxA) will be designated by the Owner to oversee and approve the completion of all commissioning activities. The CxA has the overall responsibility for planning, coordinating, and executing the commissioning process with all of the parties participating in the commissioning process. This includes the Owner, construction manager, facility operator, architect, engineer, general contractor, subcontractors, specialty subcontractors, equipment suppliers, vendors, authorities having jurisdiction and others entities as required.
 2. The General Contractor is responsible for designating a person as the Contractor Commissioning Specialist (CxC). The CxC has the overall responsibility of policing and coordinating all commissioning tasks assigned to the General Contractor and each Subcontractor Commissioning Coordinator (CC). The CxC shall have the authority to make decisions for the General Contractor in regards to the commissioning process. The CxC shall represent the General Contractor as the liaison between all Subcontractor CC's and the CxA. The CxC shall act as the focal point for gathering and coordinating Subcontractor communications, scheduling and document management directly related to the commissioning process.
- B. Commissioning is the process to verify to the Owner that systems, equipment, mechanical, electrical, controls and special systems function together properly to meet performance requirements and design intent, and as described in the Contract Documents. The General Contractor and CxC shall be responsible for executing and performing the commissioning process as outlined in this specification and in references and attachments throughout the Contract Documents. The Contractor shall furnish labor and materials sufficient to meet all requirements of building commissioning under this contract. The commissioning process is not intended to conflict with applicable building codes. Apparent conflicts shall be brought to the attention of the Owner and CxA for resolution.
- C. The General Contractor and CxC shall identify discipline Commissioning Coordinators (CC). This shall include naming a representative coordinator from each of the subcontractor entities. Each CC shall participate as a member of the project Commissioning Team.
1. Each CC shall coordinate their commissioning efforts and the efforts of their vendors with the CxC. This includes providing timely response to issues regarding their discipline/company.
 2. Each CC is responsible for providing scheduling input to the CxC on all activities that affect installation, start-up, TAB, functional performance testing, operator training, warranty, and project closeout.
 3. The CxC shall coordinate the CC commissioning activities and communicate the status of each activity to the CxA and Commissioning Team.

- D. The CxC will work with the General Contactor and commissioning coordinators to establish a Commissioning Schedule. The CxC will provide a draft schedule of primary commissioning events to the CxA and Owner for review no later than 60 days after Notice to Proceed. The draft schedule will be reviewed at the commissioning kickoff meeting, with a final schedule presented to the CxA for review and to the Owner for approval. As construction progresses, detailed schedules are more fully developed by the commissioning team.
- E. Details of the commissioning process and procedures will be incorporated into a final Commissioning Plan. The plan will be coordinated and implemented by the CxA.
- F. Construction phasing requirements that affect the commissioning process will be addressed in the final Commissioning Plan and adhered to by the General Contractor.

1.02 COMMISSIONING DATA MANAGEMENT (DM) SYSTEM

- A. The CxA shall work with the Owner and CxC to develop and implement a real-time database method of reporting the commissioned status of each piece of equipment, system and building component to be commissioned. CC's shall update the Data Management (DM) system regularly with completed commissioning activities. The DM system shall be provided by the CxA. The CxA shall provide access and orientation for use of the database by all parties. The database shall be accessible during regular construction hours to the CxA, Owner, General Contractor, CxC and CC's.
- B. A secure website will be established by the CxA for storing and organizing Contractor-generated field documents. All documentation shall be uploaded electronically in PDF format. A sample list of typical documents is provided below:
 - 1. Ductwork Air Leakage Tests
 - 2. Pipework Flushing Reports
 - 3. Pipework Pressure Tests
 - 4. Pipework Water Analysis Reports
 - 5. Equipment Diagrams
 - 6. DDC Point-to-Point Checkout Sheets
 - 7. Manufacturer Startup Reports

1.03 COMMISSIONING STANDARDS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only. Except where a date is noted, the latest version of the publication at time of contract award shall be used.

AM. SOCIETY OF HEATING, REFRIGERATING & AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE Guideline 0 (2005) The Commissioning Process-P/C: 02/2009

ASHRAE Guideline 1 (2007) HVAC&R Technical Requirements for The Commissioning Process

ASSOCIATED AIR BALANCE COUNCIL (AABC)

ACG Commissioning Guideline (2005) Commissioning Guideline

NATIONAL ENVIRONMENTAL BALANCING BUREAU (NEBB)
NEBB Commissioning Standard (2009) Procedural Standards for Whole
Building Systems Commissioning of New
Construction; 3rd Edition

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL
ASSOCIATION (SMACNA)
SMACNA Commissioning Manual (1994, 1st Ed) HVAC Systems
Commissioning Manual

1.04 SIMILAR TERMS

- A. In some instances, terminology differs between the Contract and the Commissioning Standard primarily because the intent of this Section is to use the industry standards specified, along with additional requirements listed herein to produce optimal results. Contract requirements take precedent over the corresponding ACG, NEBB, BCA or TABB requirements where differences exist.
- B. References to Pre-Functional Check (PFC) and Functional Performance Test (FPT) lists are included in other specification sections that are directly related to the commissioning process. The contractor shall be responsible for coordinating all installation, start-up, testing, and verification requirements with the requirements outlined in this specification. Where these requirements overlap or may otherwise result in a duplication of effort, the contractor shall notify the Owner and CxA, complete with supporting documentation, for review and assessment.

1.05 QUALIFICATIONS OF COMMISSIONING SPECIALIST (CXC)

- A. The CxC shall possess the qualifications of an individual specializing in the commissioning of building systems of similar scope and complexity to those of this project.
- B. The CxC shall have a minimum of 10 years experience as a project manager or project superintendent responsible for the coordination of mechanical, electrical, and plumbing systems installation, testing, and warranty repair work. The General Contractor shall immediately notify the Contracting Officer if a change of CxC personal is necessary. The General Contractor shall then resubmit qualifications of the replacement CxC for Owner review and approval.
 1. The CxC shall have documented experience with working on similar projects that include Commissioning requirements and the presence of an Owner selected CxA.
 2. Where a single individual does not have the required experience in commissioning of both mechanical and electrical system, multiple individuals with the necessary qualifications may be submitted for approval as CxC assistants under the direct management of a designated Lead CxC.

1.06 RELATED DOCUMENTS

- A. All provisions of the Contract Documents (drawings/specifications and performance criteria) apply to the work in this section. Conflicting requirements shall be brought to the Owner's attention in writing prior to completion of the bidding phase. Owner shall provide clarification in a timely manner.
- B. The following specifications may contain additional installation, testing and acceptance requirements. Interpretation of these specifications by themselves will not provide relief from the requirements stated in all other areas of the contract documents:

1. Division 01 - GENERAL REQUIREMENTS
2. Division 21 - FIRE SUPPRESSION
3. Division 22 - PLUMBING
4. Division 23 - HEATING, VENTILATING AND AIR CONDITIONING
5. Division 26 - ELECTRICAL
6. Division 27 – COMMUNICATIONS

1.07 SUBMITTALS

- A. Submittals with a "CxA" require Commissioning Authority approval. The General Contractor shall review and approve all submittals before they are reviewed by the CxA. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

Commissioning Plan; CxA

The CxA shall provide the CxC and General Contractor with a draft Commissioning Plan. The CxC and General Contractor shall review the Plan with the construction team and return it within 30 days with any recommended changes. Include contact information for all subcontractors CC's (Commissioning Coordinators). After updates are incorporated by the CxA, a final commissioning plan shall be provided to the General Contractor and Owner.

Commissioning Schedule; CxA

Prepared by the General Contractor and CxC. A preliminary commissioning schedule will be provided by the General Contractor no later than 90 days after Notice to Proceed. The schedule shall include 6 specific milestones for each piece of commissioned equipment; i.e. installation completed, start-up date, point-to-point completed, TAB completed, FPT readiness, and date of operator training. The schedule shall be updated weekly during the commissioning process.

Commissioned Equipment Naming Convention and I.D. Tagging; CxA

The Contractor and subcontractors shall develop an integrated equipment naming convention with unique I.D. tag number for each piece of commissioned equipment. The naming convention used on the Bid Documents shall be revised to comply with the Owner's final naming convention for each type of equipment and location. Electronic drawing files used for the bid documents shall be provided to the Contractor, and the Contractor shall update the electronic drawing files with the new I.D. tag numbers and then submit for approval. The approved I.D. numbering scheme shall be used by the Contractor, subcontractors, vendors and suppliers on all submittals and project closeout documentation, including O&M Manuals and documents provided to the Commissioning Authority (CxA). The updated electronic drawing files with I.D. tag numbers shall be approved prior to submitting other equipment/system submittals scheduled for commissioning.

Pre-Functional Check sheets; CxA

Draft PFC sheets shall be prepared by CxA utilizing the Data Management System. The CxC and General Contractor shall review the material and return with comments within 30 days. The CxC and General Contractor shall be responsible for designating final PFC sheet responsibility during the review. The CxA shall update the DM system check sheets with revisions approved by the Owner and information included in the approved equipment submittals. The DM system updates and check sheets shall be available to the General Contractor for use, no later than 90 days prior to beginning the pre-functional installation and start-up checks. Equipment submittal data shall be incorporated into PFC sheets by the CxA. Draft PFC sheets shall be submitted to the Owner, CxC and CC's for review and comment. Final PFC sheets shall be submitted at least 60 days prior to beginning the pre-functional checks.

Refer to Section 1.8 Systems to be Commissioned for a complete list of all systems and equipment that shall be included within the commissioning scope.

Functional Performance Test sheets; CxA

Draft FPT sheets shall be prepared by CxA utilizing the Data Management system. The FPT sheets shall be similar to the complexity illustrated by the sample FPT sheets included in the Appendix. The CxC and General Contractor shall review the material and return with comments within 30 days. The CxA shall update the DM system test sheets with revisions approved by the Owner and integrated testing information included in the approved control system sequence of operation submittals. Draft FPT sheets shall be completed only after all relevant equipment submittals and control sequences have been approved. Final FPT sheets shall be provided to the contractor at least 45 days prior to beginning the functional acceptance tests.

Refer to Section 1.9 Systems to be Commissioned for a complete list of all systems and equipment that shall be included within the commissioning scope.

Final Control System Sequence of Operations; CxA

The contractor shall provide electronic PDF copies of all final Control System Sequence of Operations. The contractor shall notify the CxA to acknowledge completion.

Equipment Diagrams; CxA

The contractor shall provide electronic PDF copies of all Equipment Diagrams. The contractor shall then update the DM system accordingly to acknowledge completion.

Equipment Submittals; CxA

For commissioned systems and building components only, provide to Owner and CxA for review & comment simultaneously with timing of Owner's review of all other project equipment/material submittals. The CxA shall provide all comments back to the A/E team in advance of the submittal return date. The A/E team shall review and incorporate the CxA submittal comments. The CxA shall incorporate approved data into PFC and FPT sheets.

Testing, Adjusting, Balancing (TAB) Procedures and Reports; CxA

The contractor shall submit test procedures for any specialty testing considered outside of the normal TAB trade association recommended procedures. Preliminary air/hydraulic TAB reports shall be supplied directly to the Owner or CxA upon request. Final TAB report shall be submitted no later than 7 days prior to beginning system functional performance tests.

Duct Air Leakage Test (DALT) Sheets; CxA

The contractor shall provide electronic PDF copies of all completed DALT sheets. The contractor shall then update the DM system accordingly to acknowledge completion.

Pipework Pressure Test Sheets; CxA

The contractor shall provide electronic PDF copies of all completed Pipework Pressure Test sheets. The contractor shall then update the DM system accordingly to acknowledge completion.

Pipework Flushing Report; CxA

The contractor shall provide electronic PDF copies of all completed Pipework Flushing Reports. The contractor shall then update the DM system accordingly to acknowledge completion.

Pipework Water Analysis Report; CxA

The contractor shall provide electronic PDF copies of all completed Pipework Water Analysis Reports. The contractor shall then update the DM system accordingly to acknowledge completion.

Fire Alarm / Smoke Control System Test Plan and Report; CxA

The contractor shall submit the Fire Alarm and Smoke Control system test plan, including FA/smoke control matrix, no later than 90 days prior to beginning field testing. Final test report shall be submitted to the Owner, CxA and the designated Fire Protection Engineer for approval.

Manufacturer Startup Reports; CxA

The contractor shall provide electronic PDF copies of all completed Manufacturer Startup Reports. The contractor shall then update the DM system accordingly to acknowledge completion.

DDC Point-to-Point Checkout Sheets; CxA

The contractor shall provide electronic PDF copies of all completed DDC Point-to-Point checkout sheets. The contractor shall then update the DM system accordingly to acknowledge completion.

Trending Reports; CxA

The contractor shall provide trending information from the Building Management Control System (BMCS). Individual trend graphs for each system and component shall be setup using the appropriate engineering scales and shall be provided in 8-1/2x11 PDF format with title block, name, location and scaling parameters labeled in a legible and usable manner. The individual PDF file names shall be in accordance with the CxA naming conventions used in the Final Commissioning Record.

A complete list of proposed trending fields, complete with sampling rate, shall be submitted to the Owner and CxA for approval, along with sample graphs. Trending requirements shall be continually refined as construction progresses with final approval from the CxA and Owner.

Contractor Commissioning Specialist (CxC); CxA

Submit CxC's qualifications and supporting documentation no later than 21 days after Notice to Proceed. The documentation shall include similar project complexity, supervisory experience, project experience, dates, employers and reference names/phone numbers.

Test Equipment Calibration Certificates; CxA

Submit no later than 30 days prior to beginning the pre-functional installation and start-up checks. Updated certificates shall be provided prior to expiration dates.

Training of Owner's Operating Personnel; CxA

Submit dates and proposed training agenda for each type of equipment and system no later than 90 days prior to scheduled completion of functional acceptance tests. Training shall include the O&M Manuals, as well as hands-on and classroom instruction manuals. Videotape sessions and submit for approval.

Complete training prior to Substantial Completion and commencement of Warranty period.

1.08 SYSTEMS TO BE COMMISSIONED

A. The systems listed below shall include any subsystems, components or peripheral devices that form a complete functional system, including any associated controls and control equipment.

1. Building Automation Systems

- a. Building Management and Control System (BMCS)
- b. Control Panels and Controllers
- c. Wiring and Devices
- d. Instrument Air systems
- e. Sensors, Indicators, Transmitters and Devices
- f. Actuators and Control Valves
- g. Control Dampers and Smoke Dampers
- h. Power Systems (Emergency Power and UPS)
- i. Interface with Fire Alarm System
- j. Interface with 3rd Party Equipment
- k. Fireman's Override Panel
- l. I/O Point Schedule
- m. Sequence of Operation and Programming for all equipment and systems identified
- n. Software for all modes of operation (normal, unoccupied, emergency shutdown, load shedding, failure and alarm)
- o. Equipment alarm points
- p. Graphic user interface

2. Mechanical Systems

- a. All equipment of the heating, ventilating, and air conditioning systems i

3. Plumbing Systems

- a. Plumbing and recirculation pumps
- b. Water heaters

4. Electrical Systems

- a. Interior lighting and control system
- b. Exterior lighting and control system
- c. Emergency power system

1.09 ABBREVIATIONS

- A. A/E: Architect/Engineer
- B. BOD: Basis of Design
- C. Cx: Commissioning
- D. CxA: Commissioning Authority (independent commissioning authority designated by the Owner)

- E. CxC: General Contractor commissioning specialist
- F. CC: Commissioning Coordinator(s)
- G. CM: Construction Manager (the Owner's Representative)
- H. FPT: Functional Performance Test
- I. MEP: Mechanical/Electrical/Plumbing
- J. O&M: Operations and Maintenance
- K. OPR: Owners Project Requirements
- L. PFC: Pre-functional Checklist
- M. PFT: Pre-functional Test
- N. PM: Project Manager (Company Representative)
- O. Sub: Subcontractor(s)
- P. TAB: Testing, Adjusting, and Balancing
- Q. VAV: Variable Air Volume
- R. VFD: Variable Frequency Drive

1.10 DEFINITIONS

- A. Acceptable Performance: A component or system being able to meet specified design parameters under actual load including satisfactory documented completion of all functional performance tests, control system trending and resolution of outstanding issues.
- B. Acceptance Phase: The phase of construction after startup and initial checkout when functional performance tests, O&M documentation review and training occurs.
- C. Architect/Engineer: Architect & Engineer of record
- D. Areas of Conflict: Where commissioning requirements conflict with design provisions or other requirements of the Contract Documents, prompting issuance of a request for clarification.
- E. Basis of Design (BOD): A document prepared by the engineer of record that records concepts, calculations, decisions, and product selections used to meet the Owner's Project Requirements (OPR) and to satisfy applicable regulatory requirements, standards, and guidelines. The document includes both narrative descriptions and lists of individual items that support the design process.
- F. Commissioning: Documented confirmation that building systems function in compliance with criteria set forth in the Contract Documents, OPR and BOD. The process documents all required user training and O&M materials have been properly provided.

- G. Commissioning Authority (CxA): An independent entity designated by the Owner, not associated with the General Contractor. This entity oversees and approves the completion of all General Contractor and CxC commissioning activities.
- H. Commissioning Coordinator (CC): This entity is a representative of contractors/subcontractors who is empowered to make timely decisions, as they pertain to commissioning, for their discipline/company. The CC is responsible for providing scheduling input on all the activities related to their Scope-of-Work that affect installation, start-up, TAB, functional performance testing, operator training, warranty and project closeout.
- I. Commissioning Plan: A document prepared by the CxA and approved by the Owner that outlines the Cx team organization, communication paths, schedule, allocation of resources, matrix of responsibilities, installation/testing requirements, and documentation requirements of the commissioning process. A draft of the plan must be developed and provided to all commissioning team members before the start of construction. The plan shall be updated by the CxC as the construction process evolves.
- J. Commissioning Report: The Commissioning Report is prepared and maintained by the CxC and shall consist of an executive summary of the process. The Commissioning Report includes inspection reports, start-up reports, TAB verification reports, start-up and functional test reports. The results of failed tests shall be included along with a description of the corrective actions taken.
- K. General Contractor Commissioning Specialist (CxC): Hired by the General Contractor, this person or entity coordinates the execution of commissioning activities with all of the parties participating in the commissioning process. This includes the Owner, CxA, construction manager, facility operator, architect, engineer, general contractor, subcontractors, specialty subcontractors, equipment suppliers, vendors, authorities having jurisdiction and other entities as required.
- L. Contract Documents: The documents binding on parties involved in the construction of this project (drawings, specifications, performance criteria, change orders, amendments, contracts, Cx plan, etc.).
- M. Contractor: The General Contractor and subcontractors/vendors.
- N. Control System: The building energy management and automated control system.
- O. Construction Manager: The Owner's representative.
- P. Deferred Functional Tests: Tests that are performed after substantial completion due to partial occupancy, equipment, seasonal requirements, design or other site conditions that disallow the test from being performed prior to substantial completion. Deferred functional test plans must be approved by the CxC and CxA.
- Q. Deficiency: A condition in the installation or function of a component, piece of equipment or system that is not in compliance with the contract documents or OPR.
- R. Design Intent: A dynamic document that provides the explanation of the ideas, concepts and criteria that are considered to be very important to the Owner. It is initially the outcome of the programming and conceptual design phases.
- S. Final Commissioning Report: Document prepared by the CxA and approved by the Owner, which details the actual Cx procedures performed, inspections, testing results,

and the final version of the Issues Log. A copy of the final report is furnished to the Owner and CxA as a menu-driven CD for future reference.

- T. Functional Performance Test (FPT): The FPT checklists are prepared by the CxA utilizing the Data Management system, coordinated with the CxC/General Contractor, and approved by the Owner. The checklists are used by the CxC/General Contractor to document the full range of checks and tests carried out to establish that all components, sub-systems, systems and interfaces between systems function in accordance with the Contract Documents. In this context, "function" includes all modes and sequences of control operation, all interlocks and conditional control responses and all specified responses to abnormal emergency conditions. The CxA develops the written functional test procedures form in a sequential format and then coordinates and documents the actual testing which is usually performed by the installing contractor or vendor. Functional performance testing takes place after pre-functional (installation and start-up) tests have been completed and approved by the CxC and Owner.
- U. Issues Log: A list of systems/equipment or procedural deficiencies and issues that have been noted. The list is prepared by the CxA and provided to the CxC at regular intervals. It includes the current disposition of each issue and the date of final resolution. Deficiencies include products/material, installation, service, or systems/equipment performance that do not comply with the Contract Documents and/or Commissioning Plan.
- V. Monitoring: Recording parameters (i.e. flow, current, status, pressure, temperature, etc.) of equipment operation using data loggers or the trending capabilities of control systems.
- W. O&M Manuals: Manuals used for the training, operations and maintenance of systems & equipment. Manufacturer's data should be edited such that the O&M materials include information specific to this project.
- X. Owner: Entity with the highest level of responsibility for directing the project.
- Y. Owner-Contracted Tests: Tests paid for by the Owner outside the contractor's contract.
- Z. Owner's Representative: Construction Manager or other individuals with the authority to make contractual decisions on behalf of the Owner. The Commissioning Plan should be kept up to date by the CxA to include the names/contact information for each of the Owner's representatives.
- AA. Owner's Project Requirements (OPR): Non-technical document developed by the Owner, architect and engineers. It is updated at regular intervals to state the intended concepts, goals, budget, performance and other criteria to which the completed project must conform. It includes expectations of how the building will be used and operated. This document is the basis for building commissioning. It is used by the engineers to develop their basis of design documentation.
- BB. Pre-functional Checklist (PFC): The PFC sheets are prepared by the CxA utilizing the Data Management system, reviewed by the CxC/General Contractor, and approved by the Owner. They are used to verify systems/equipment that installation and start-up activities comply with the Contract Documents, equipment submittals and manufacturers' instructions. The CxC and General Contractor shall use the checklists to verify completeness of inspections, tests/procedures to prepare equipment for initial start-up and proper/continuous operation (such as cleanliness, belt tension, oil levels OK, labels affixed, gages in place, sensors calibrated, initial settings, etc.). The checksheets shall be used to verify system set points, operating strategies, required component testing, correct rotation, and damper positions. The checksheets are completed by the

CxC/General Contractor, back-checked & approved (fully or by random sample) by the CxA, and then provided to the Owner prior to commencement of the functional performance testing process.

- CC. Project Manager (PM): A staff position for a particular entity with decision making authority.
- DD. Seasonal Performance Tests: Functional performance tests that are deferred until system design conditions can be replicated or simulated.
- EE. Specifications: Part of the contract documents that supplement the design drawings and related performance criteria. Specifications include procedures implied in the Commissioning Plan.
- FF. Start-up: The initial start-up or activation of dynamic equipment.
- GG. Subcontractor: Members of the construction team providing a service or product that are contracted by the General Contractor.
- HH. Test Engineer: This entity is a representative of the contractors/ subcontractors who is empowered to carry out field testing of installed equipment and systems. The Test Engineer is responsible for providing feedback to the commissioning team of any deficiencies affecting installation, start-up, TAB, functional performance testing, operator training and warranty. The Test Engineer may request an equipment vendor representative to attend commissioning meetings to resolve equipment problems or deficiencies, with prior approval from the CxA.
- II. Training: Organized instruction and hands-on demonstration of operating and maintaining systems and equipment.
- JJ. Trending: Monitoring of equipment and sequences using the building control system or data loggers.
- KK. Vendor: Suppliers of equipment or service.

1.11 COMMISSIONING PLAN

- A. The Commissioning Plan is prepared by the CxA, with assistance from the CxC and is a tool through which the commissioning process is described and incorporates the roles of the General Contractor, CC's, CxC and CxA relative to the commissioning process. Commissioning team members are all representatives whose participation is of benefit in the delivery of a fully functioning building.
- B. The plan shall describe the communication, authority and responsibility of commissioning team members. The Preliminary Commissioning Plan shall include the following:
1. The purpose of commissioning
 2. Detail the commissioning process
 3. Commissioning team members' responsibilities
 4. Schedule of Commissioning Activities
 5. Documentation Requirements
 6. Communication and Reporting Protocols
 7. Systems to be Commissioned
 8. Incorporation of electronic Data Management system for documentation of activities
 9. Samples of Pre-functional Checklists (PFC) and Functional Performance Tests (FPT)

- C. The Final Commissioning Plan shall include the following:
1. All items listed in the Preliminary Commissioning Plan updated to reflect proposed changes
 2. Detailed Pre-Functional Checklist sheets; are used to verify systems/equipment that installation and start-up activities comply with the Contract Documents, equipment submittals and manufacturers' instructions.
 3. Detailed Functional Performance Test Procedures; the detailed functional performance test procedures shall explain, step-by-step, the actions and expected results that will demonstrate that the system performs in accordance with the sequences of operation, and other contract documents.
 4. Guidelines for acceptance of each system and equipment piece.
 5. Expected results for each test shall be included.
 6. Updated Issues Log issued at regular intervals to identify deficiencies and issues

1.12 DUTIES OF COMMISSIONING AUTHORITY (CxA)

- A. The primary role of the CxA is to develop and implement the Commissioning Plan and to oversee/recommend acceptance of all commissioning activities assigned to the General Contractor and CxC.
- B. Work with CxC to obtain copies of all shop drawings, manufacturer's literature, maintenance information or other information as may be needed for systems to be commissioned.
- C. Evaluate information provided by the CxC and CC's to document proper execution of the Commissioning Plan and functional performance tests.
- D. Evaluate all proposed start-up and Pre-functional Construction Checklists documentation as supplied by the CxC.
- E. Review and comment on submittals for all systems to be commissioned including controls system, wiring diagrams and narrative sequences of operation, in time for use in preparing the Functional Test Procedures.
- F. Review preliminary TAB report for accuracy prior to initiation of functional testing.
- G. Obtain complete operation and maintenance information and as-built drawings for verification, organization and distribution from the CxC.
- H. Review and participate in site observations to follow installation progress and to verify system installation and readiness for testing.
- I. Review submittal of all required pre-functional and start-up documentation provided by Contractor for completeness and reasonableness. This includes installation documentation, start-up documentation, point-to-point checklists and preliminary TAB report, prior to initiation of functional testing. Make recommendations of acceptance of documentation to the Owner.
- J. Participate in and witness functional testing as defined in the Commissioning Plan and Functional Test Procedures. All testing shall be performed by the Contractor and subcontractors and documented by the CxA. Make recommendations of acceptance of documentation to the Owner.

- K. Lead commissioning meetings and record the minutes of each meeting. Distribute meeting minutes to the Owner, CxC and CC's.
- L. Provide project reports in a timely manner.
- M. Develop and maintain an Issues Log. Review documented inconsistencies or deficiencies in system operations and system compliance. Make recommendations and assist in developing plans to address the open issues.
- N. When commissioning has been successfully completed, make recommendations for acceptance to the Owner.
- O. Develop draft Final Commissioning Report, with assistance from the CxC, of all commissioning activities and test results that occurred during the project and submit to the Owner for review.
- P. Observe and witness training of Owner personnel on commissioning systems and equipment. Make recommendations of acceptance of training to the Owner.
- Q. Participate in seasonal/deferred tests. Oversee activities of all participants and make recommendations of acceptance of testing to the Owner.

1.13 DUTIES OF CONTRACTOR COMMISSIONING SPECIALIST (CXC)

- A. The primary role of the CxC is to coordinate and police execution of the Commissioning Plan with the General Contractor and each Subcontractor Commissioning Coordinator (CC) through the organization and leadership of the project commissioning team.
- B. The CxC is not responsible for the design concepts, design criteria, code compliance, code inspections, construction scheduling, cost estimating, or construction management.
- C. Obtain copies of all shop drawings, manufacturer's literature, maintenance information or other information as may be needed for systems to be commissioned.
- D. Collect the information needed for development of a complete Commissioning Plan and functional performance tests.
- E. Obtain all proposed start-up and Pre-functional Construction Checklists documentation.
- F. Obtain updates to all project documentation to reflect all supplemental instructions, addenda or other revisions to the project construction documents.
- G. Obtain submittals for all systems to be commissioned including control systems, wiring diagrams and narrative sequences of operation, in time for use in preparing the Functional Test Procedures.
- H. Obtain preliminary TAB report, indicating all actual field values recorded, prior to initiation of functional testing.
- I. Obtain complete operation and maintenance information and as-built drawings for verification, organization and distribution.
- J. Coordinate and assist with the Preliminary and Final Commissioning Plans with the CxA.
- K. As part of Final Commissioning Plan, review the draft Pre-functional Checklists and Functional Test Procedures prepared by the CxA, utilizing the Data Management system,

with information gathered from Contract Documents and final equipment submittals including narrative sequences of operation, control diagrams and software code for execution with the assistance of Contractor staff as required. Sample documents, located in the Appendix, are examples representing the scope and rigor of the commissioning procedures required, and shall be used as the basis for developing the detailed checklists and functional performance test procedures.

- L. Perform site observations to follow installation progress and to verify system installation and readiness for testing. The minimum number of site visits shall be sufficient to complete site observations at each of the milestones: 30%, 60% and 90% phase completion. Additional site observation trips may be required to accommodate specific project goals and critical installation activities.
- M. Schedule, direct and witness all 'Pre-Testing' of the FPT scripts prior to final witness and testing by the CxA, as defined in the Commissioning Plan and Functional Test Procedures. All 'Pre-Testing' shall be performed by the Contractor and subcontractors and documented by the Commissioning Specialist.
- N. Attend commissioning scoping meetings. These meetings shall further define the testing requirements and participation of each entity with the CxC and CxA.
- O. Attend regular meetings to facilitate the commissioning process during the installation & startup period, and weekly meetings during the functional testing period. Attend other meetings as required when problems arise.
- P. Provide site observation, FPT 'Pre-Testing' or other project reports in a timely manner.
- Q. Document inconsistencies or deficiencies in system operations and system compliance. System deficiencies shall be forwarded to the Owner and CxA and documented in the CxA Issues Log.
- R. Coordinate the participation of Owner's personnel with equipment, component and systems performance verification and participation in required training.
- S. Coordinate and document training of Owner personnel on commissioning systems and equipment. CxC shall review all training materials prior to actual training sessions.
- T. Coordinate and conduct seasonal/deferred tests. Coordinate activities all participants and report results to the Owner and CxA.

1.14 DUTIES OF GENERAL CONTRACTOR AND COMMISSIONING COORDINATORS (CC)

- A. Attend commissioning scoping meetings. These meetings shall further define the testing requirements and participation of each entity with the CxC and CxA.
- B. Attend regular meetings to facilitate the commissioning process during the installation and startup period, and weekly meetings during the functional testing period. Attend other meetings as required when problems arise.
- C. Coordinate with the CxC and prepare a Commissioning Schedule. Allow sufficient time before functional performance test dates so that testing, adjusting and balancing activities for each system can be completed. Submit the Commissioning Schedule for Owner and CxA review and approval.
- D. The Commissioning Schedule shall include several important milestones for each piece of commissioned equipment & system; Milestones include installation, start-up, point-to-

- point checkout, TAB, functional performance test, and operator training. Provide a separate matrix indicating the length and start of warranty period for each commissioned building component, equipment and system.
- E. Attend special meetings intended to clarify the controls sequences of operation and reconcile any differences with the design intent after the first sequence of operations is submitted and reviewed.
 - F. Provide equipment data required for development and finalization of the pre-functional check (PFC) and functional performance test (FPT) procedures.
 - G. The General Contractor or relevant Subcontractor shall be responsible for operating and manipulating all commissioned systems and equipment throughout the commissioning phase.
 - H. Develop a comprehensive start-up plan. The start-up plan shall be developed with the help of the CxC and integrated with the commissioning plan.
 - I. The controls contractor shall be responsible for coordinating development of a point-to-point verification plan. The plan shall be developed with the help of the CxC and integrated with the commissioning plan.
 - J. The electrical prime contractor shall provide the necessary power to allow mechanical equipment start-up activities to be accomplished according to the approved schedule. Certified personnel shall be provided who are able to conduct specialized testing of electrical power and lighting systems.
 - K. The mechanical prime contractor shall be responsible for installing pressure/temperature test ports (i.e. - Pete's plugs) in all piping systems locations where DDC controls pressure/temperature sensors and transmitters are located.
 - L. Utilize the Pre-Functional Checklists (PFC) and Functional Performance Test (FPT) sheets prepared by the CxA. Coordinate and integrate the content of the PFC/FPT sheets with requirements of electronic Data Management system.
 - M. Provide skilled technicians familiar with the project for start-up, pre-functional and functional performance testing.
 - N. Correct deficiencies found during startup and functional performance testing in a timely manner to allow for re-testing activities within the commissioning schedule.
 - O. Submit the completed Pre-Functional Checklists to the CxC and CxA for review to verify prerequisite requirements are fulfilled before functional performance testing is scheduled to start. Start-up documentation and point-to-point test results are required as a prerequisite to functional performance testing.
 - P. Provide all equipment submittals, equipment start-up forms, field static testing reports (i.e. circuit breaker test reports, megger test reports, torque testing reports, etc.) to the CxC and CxA for review and approval.
 - Q. Report TAB deficiencies to the CxC and CxA. The mechanical contractor shall correct the deficiencies in a timely manner so that functional performance tests can be completed on schedule. The cost of belt and sheave changes shall be included in the bid base price.
 - R. TAB contractor shall coordinate with the CxC and CxA and provide all set-point value requirements for input into the controls system; including minimum outside air damper

positions, return/supply fan VFD speed mapping, pumping loop differential pressure setpoints, duct system static pressure setpoints, air terminal unit flow sensor calibration factors, etc.

- S. Maintain and update as-built drawings each week during construction, including as-builts for the control system.
- T. Final O&M manuals shall incorporate all equipment/system changes, including changes related to the control system sequence of operations.
- U. Provide operations staff training for the commissioned equipment and systems specified under this section. Agendas and content of training sessions shall be pre-approved by the CxA and Owner.

1.15 OWNER'S RESPONSIBILITIES

- A. Provide direction as necessary to the Commissioning Authority (CxA). The CxA is the Owner's independent representative responsible for providing oversight of all commissioning activities. CxA has authority to accept or reject completion of commissioning activities.
- B. Assign operations and maintenance personnel, and schedule them to participate in Commissioning team activities.
- C. Review RFI's and other commissioning submittals in a timely matter.
- D. Make final decisions regarding commissioning process and issues.

1.16 ARCHITECT/ENGINEER OF RECORD RESPONSIBILITIES

- A. Review the Cx documentation and provide comments as necessary to the Owner and CxA.
- B. The architect/engineering team shall provide, in a timely manner, the necessary representatives from the design team as required for completing the commissioning processes. Design team members will be expected to provide prompt replies to RFI's issued during the Cx process. Copies of all submittals pertaining to the building envelope, equipment and systems to be commissioned shall be reviewed and approved by the A/E simultaneously with the CxC, Owner, and CxA review.
- C. Participate in determination of final controls system input/output points list and sequences of operation as required to complete functional test procedures.
- D. Assist the Commissioning team in resolving technical problems that arise during construction, start-up and functional testing.

PART 2 PRODUCTS

2.1 TEST EQUIPMENT

- A. Provide the skilled technicians and all test equipment necessary to complete the start-up and functional performance test commissioning requirements of all commissioned equipment, components and systems. Submit documentation showing calibration certificates are current for all test equipment.

- B. Provide the skilled technicians and all test equipment necessary to complete the preliminary and functional performance test commissioning requirements. Submit documentation showing calibration certificates are current for all test equipment.
- C. Provide all specialized or proprietary test equipment and software required by equipment/system vendors and manufacturer to complete the testing and commissioning requirements. The equipment shall be provided by the contractor at no additional cost to the Owner and shall become the property of the Owner upon system acceptance. When required, the manufacturer/vendor shall demonstrate use of the test equipment and assist the contractor and CxA in the commissioning process.
- D. All test equipment shall utilize Standard measurements unless otherwise required by the CxC or Owner.

PART 3 EXECUTION

3.1 WORK PRIOR TO COMMISSIONING

- A. A commissioning plan will be developed and finalized by the CxA, with assistance from the CxC/General Contractor and submitted to the Owner for approval. The CxC and CC's are obligated to assist the CxA in preparing the commissioning plan by providing all necessary information pertaining to the actual equipment and installation, identification of parties responsible for startup activities, and schedule dates for equipment start-up & testing activities.
- B. Complete all phases of work so each system can be started, tested, adjusted, balanced, and otherwise commissioned to the satisfaction of the CxA. The contractor has primary start-up responsibilities with obligations to complete systems, including all sub-systems, so they are fully functional. This includes the complete installation of all equipment, materials, pipe, duct, wire, insulation, controls, etc., per the contract documents and related directives, clarifications, change orders, etc.
- C. If Contractor-initiated system changes have been made that alter the commissioning process, the CxC shall submit the changes to the CxA for review, who will submit to the Owner for approval.

3.2 PARTICIPATION IN COMMISSIONING

- A. Provide skilled technicians to start-up all systems. These same technicians shall be made available to assist the CxA in completing the commissioning process.
- B. The technicians shall be present for sufficient durations during the agreed-upon commissioning schedule to complete the necessary tests, adjustments, troubleshooting, problems resolution and correction of deficiencies. This process shall continue until required system performance is obtained.
- C. The Owner and CxA reserve the right to judge the appropriateness and qualifications of the technicians relative to each item of equipment or system. Such qualifications include expert knowledge relative to the specific equipment involved, adequate documentation, proper tools, attitude and willingness as a team player to get the job done.

3.3 MISCELLANEOUS SUPPORT

- A. General Contractor, CxC and CC's shall coordinate the removal and replacement of covers for mechanical equipment, open access panels, raised floor panels, flooring, ceiling tiles, etc., to permit the Owner and CxA and/or their representatives to observe

installation and functionality of equipment and controls. The General Contractor shall furnish ladders, lifts, flashlights, and other assistance to maintain safe electrical conditions as required.

3.4 NOTIFICATION OF SYSTEM COMPLETION

- A. Two weeks prior to the beginning of start-up or test activities for each system, the CxC shall provide a detailed look-ahead schedule. This schedule shall be updated weekly and shall provide information to include date, time, beginning location, and anticipated duration of each start-up or test activity. CxC shall notify the CxA in writing at least 72 hours in advance of any changes to this schedule. The Owner and CxA shall reserve the right to witness all equipment start-up by the manufacturer's representative. The CxC shall document start-up of all equipment and provide information to the CxA. The Owner may choose to witness the start-up of equipment.
- B. When systems are ready for final commissioning verification, CxC shall notify the CxA, in writing, at least 72 hours in advance.

3.5 VERIFICATION OF PERFORMANCE

- A. Design and submittal data shall be entered into the DM system Pre-Functional Checklist (PFC) sheets for all commissioned systems and equipment by the CxA.
- B. As-built data shall be entered into the DM system PFC sheets by the Contractor.
- C. Discrepancies between submitted and installed information shall be highlighted and entered into the Cx Issues Log by the CxA for resolution.
- D. Installation and startup information will be entered into the DM system by the Contractor using the PFC sheets.
- E. Completed PFC sheets shall be backchecked by the CxA.
- F. The CxA shall monitor installation progress of commissioned systems and equipment by tracking PFC completion using status reports generated by the DM system.
- G. Verification of performance will take place after formal notice from the CC that the following steps have been completed:
 - 1. All Pre-Functional Check sheets (installation, start-up and operation) have been signed-off.
 - 2. FPT scripts have been 'Pre-Tested' and the system and/or equipment is deemed ready for final witnessing and testing by the CxA.
- H. Performance demonstration will be done by the systems and equipment trade representatives and shall be coordinated by the CxC and witnessed by the CxA.
- I. Verification will include demonstration of performance listed in the FPT sheets prepared by the CxA.
- J. The witnessed performance data will be added to the FPT sheets at the time of verification.
- K. The Contractor shall notify the CxA and Owner as soon as possible of any issues identified during construction that may affect the commissioning process or final system performance.

3.6 WORK TO RESOLVE DEFICIENCIES

- A. Items such as excessive noise, building thermal/air leakage, improper adjustments, misapplied equipment and deficient performance of equipment under varying loads will result in additional work being required to complete commissioning of the systems. Whereas all CC's will have input and the opportunity to discuss the work and resolution of problems with the CxC, the Owner and CxA will have final authority for accepting the work plan for achieving acceptable performance of systems and equipment.
- B. Corrective work shall be completed by the General Contractor in a timely fashion to permit the on time completion of the commissioning process per the approved commissioning schedule. When requested by the Owner or CxA, the GC or relevant Subcontractor shall provide a manufacturer's representative at no additional cost to the Owner.
- C. Experimentation to render system performance will be permitted:
 - 1. If the CxC deems the experimentation work to be ineffective or untimely as it relates to the commissioning process, the CxC will notify the Owner and CxA indicating the nature of the problem, expected steps to be taken, and the deadline for completion of activities.
 - 2. If deadlines pass without resolution of the problem, the CxA and Owner reserve the right to obtain supplementary services and/or equipment to resolve the problem. This process shall not change the General Contractor's warranty obligations for the effected system and/or equipment.
 - 3. Costs incurred to solve the problem in an expeditious manner will be the General Contractor's responsibility.

3.7 SEASONAL AND DEFERRED COMMISSIONING AND OCCUPANCY VARIATIONS

- A. Seasonal commissioning pertains to testing under full-load conditions during peak heating, cooling, and humidification seasons, as well as part-load conditions in the spring and fall:
 - 1. Initial commissioning will be done by the CxC/General Contractor and witnessed by the CxA prior to substantial completion, regardless of season.
 - 2. Commissioning under conditions representing other than the current season shall be undertaken at a later time by the CxC/General Contractor and witnessed by the CxA. The CxC shall coordinate seasonal / deferred testing with TAB Contractor for opposite season testing.
 - 3. Discrepancies discovered after substantial completion with equipment installation, performance or workmanship will be handled as warranty items by the CxC/General Contractor.
 - 4. CxA shall update Final Commissioning Report to include seasonal testing and warranty period activities.
 - 5. CxC shall coordinate the schedule and status of all commissioning activities with the Owner and CxA. CxA shall provide oversight and verify completeness of all commissioning activities, and report status directly to the Owner.
- B. Deferred commissioning pertains to any remaining testing that was disallowed from being performed prior to substantial completion.
 - 1. Discrepancies discovered after substantial completion with equipment installation, performance or workmanship will be handled as warranty items by the CxC/General Contractor.

2. CxA shall update Final Commissioning Report to include deferred testing and warranty period activities.

3.8 COMMISSIONING ACCEPTANCE CRITERIA

- A. The CxA acceptance criteria will be developed from the plans, specifications, and equipment manufacturer's operating criteria. The contractor is responsible for meeting contractual requirements found in the OPR plans and specifications. The contractor is reminded of their responsibility for furnishing a working system. All items logged as deficient need to be corrected per the plans and specifications.

3.9 RETESTING AND RECOMMISSIONING

- A. Any fault with material/equipment, integrated tests, or in any part of the installation revealed by commissioning tests shall be investigated, replaced, or repaired by the General Contractor.
- B. Commissioning tests shall be repeated at the Contractor's expense until no fault appears and until the repeated test results are approved by the CxA and Owner.
- C. The Contractor will be assessed the actual cost to the Owner for the CxA to witness the 2nd, 3rd and any additional re-testing of a particular piece of equipment or system. Such costs will be deducted from the contract amount due to the Contractor.

3.10 OPERATIONS AND MAINTENANCE MANUALS

- A. The General Contractor, with assistance from the CxC, shall provide the approved O&M manuals to the Owner and CxA prior to commencement of training. The manuals shall contain at a minimum the following information:
 1. Design data
 2. Operating data
 - a. Performance curves
 - b. Acceptance criteria
 - c. Control sequence of operations
 - d. Start-up reports
 - e. TAB reports
 - f. Maintenance recommendations and requirements
 - g. Warranty certificates
- B. The General Contractor shall provide menu-driven CD's of the O&M materials to the Owner and CxA. The material will be used in staff training sessions.

3.11 TRAINING OWNER 'S OPERATIONS & MAINTENANCE STAFF

- A. The Owner's operations and maintenance personnel (and, if applicable, the Owner's contracted maintenance vendors) shall be given comprehensive training in the understanding of the systems and the operation, maintenance, and repair of each major piece of equipment and system per the approved agenda and curriculum.
- B. The general contractor will be responsible for coordinating and scheduling the training with the Owner. Hands-on training shall include, but not be limited to, start-up, operation in all modes possible, repair, safety, shutdown and emergency procedures, if any.

- C. On-site classroom training sessions shall be scheduled as part of the training requirements.
- D. The contractor or his representative shall conduct all sessions and shall add to each session any special information relating to the details of installation of the equipment as it might impact the operation, maintenance, and repair.
- E. Training shall include a review of the record as-built drawings and O&M data.
- F. Each sub contractor and vendor responsible for training shall submit a written training plan to the CxA and Owner for review and approval prior to training. The training plan shall cover, at a minimum, the following elements:
 - 1. Equipment included in each training session.
 - 2. Location of the equipment.
 - 3. Intended audience including names and contact information.
 - 4. Location, date/time and duration of each training session.
 - 5. Topics and learning objectives.
 - 6. Instructor including individual's contact information and qualifications for each topic.
 - 7. All training methods shall include a classroom lecture and an actual operational demonstration of start up, turn-down and maintenance procedures.

3.12 FINAL COMMISSIONING REPORT

- A. The CxA will submit a final report to the Owner which includes a statement that the project meets the Owner 's design intent, and includes a narrative of the results of the completed inspections, operational and functional testing. The final report will also include an outline of the Issue Log and dates identifying items found and dates items corrected. All open items will be identified in the report. Technical data from the equipment shall be included as well as all test results, manufacturer's start-up sheets, and testing, adjusting, & balancing (TAB) reports when possible.
- B. At the conclusion of the commissioning process and after the final summary has been completed, the CxA will formally recommend system and equipment performance acceptance to the Owner. The Owner will make formal system acceptance to the Contracting Officer. Copies will be forwarded to the contractor.
- C. The final commissioning report will include:
 - 1. Executive summary
 - 2. Commissioning plan
 - 3. Commissioning site visit reports
 - 4. Submittal reviews
 - 5. O&M data reviews
 - 6. Training record & evaluations
 - 7. Pre-functional and Functional Test procedures and checklists
 - 8. TAB Reports
 - 9. System/equipment data sheets
 - 10. Pre-commissioning checklists with start-up reports
 - 11. Inspection reports
 - 12. Issues Log (cleared and open items)
- D. The CxA will furnish (3) DVD copies of the final report and 10-month warranty review report to the Owner. The DVD's shall be indexed and menu-driven with all required documentation included. Owner comments shall be incorporated into delivery of (3) final DVD copies.

END OF SECTION 01 91 13

SECTION 02 40 00**DEMOLITION AND STRUCTURE MOVING****PART I - GENERAL****1.1 SUMMARY****A. Description**

1. This Section specifies demolition work, including but not limited to, the existing facilities identified for removal on the Contract Drawings and as specified herein.
2. The Work includes complete removal and disposal of existing facilities from the top of the structure to the bottom of its foundations unless otherwise indicated on drawings.
3. Demolition shall occur in areas to be cleared and grubbed, and from other areas shown on the Contract Drawings.
4. Existing facilities include but are not limited to the following: pavements, sidewalks, curbs and gutters, signs, posts, poles and pole foundations, signal mast arms, concrete foundations, railroad track, turnouts and other appurtenances, fences, walls, irrigation lines, storm drain lines, water lines, conduits, manholes, catch basins, pipes, clean out boxes, culverts, headwalls, inlets, street lights, landscape areas, abandoned utility vaults, bollards, barrier, sprinkler systems, concrete grade crossing panels, and other facilities designated to be removed or the removal of which is necessary for the accomplishment of the improvements.

1.2 SUBMITTALS

- A. Submittals shall be made in accordance with the requirements of the Project Quality Plan, except as modified herein.
- B. The following shall be submitted at least five days before any demolition is performed:
 1. A copy of the request to utility companies owning or agency controlling services and appurtenances affected by demolition Work for discontinuance of services along with certificates of severance.
 2. Demolition permits from the city and county agencies, as appropriate.
 3. Traffic permits from the jurisdictional agency for transport of debris.
 4. Permits and releases from each owner of property where demolition debris will be deposited absolving the Engineer of responsibility in connection with such disposal.
 5. Demolition procedures and operations sequence.
 6. For the demolition of any building, the contractor shall comply with the requirements and permitting process of Missouri's Department of Natural Resources.

1.3 JOB CONDITIONS

- A. KCMO assumes no responsibility for the condition of existing structures to be demolished. Plans are not available for structures to be demolished under this Contract. Contractor shall thoroughly investigate each item prior to commencement of demolition to verify that the item is intended for demolition and to determine the best and safest procedure for accomplishing the demolition.
- B. Utilities
- Arrangements shall be made with the appropriate utility owner for the removal, rerouting or capping of utilities and complying with its regulations.
- C. Street and Road Closures
1. Arrangements shall be made with appropriate state, city, or county agency for temporary closing of public streets or highways to traffic as necessary, and for the rerouting of traffic. Closures and rerouting of traffic shall comply with local agency requirements.
 2. Temporary signs, barricades, flashing lights, and flaggers shall be provided as specified in General Provisions or as necessitated by the work and removed upon completion of work.
- D. Maintenance of Traffic
1. Maintain traffic in accordance with applicable codes and the Contract General Provisions to ensure continuous safety of traffic. Construct, maintain and remove on completion of work, temporary canopies and other structures intended for protection for pedestrians and the segregation of vehicular traffic.
 2. Cuts in traffic areas shall be bridged with steel plates of adequate strength and thickness or by other approved means.
 3. Traffic areas shall be kept free from debris and spillage of materials.
- E. Protection and Restoration
1. Prevent damage to pipes, conduits, wires, cables and structures above and below ground which are not designated for removal. Damaged items shall be repaired or replaced at no cost to KCMO.
 2. Explosives of any kind shall not be used in the demolition of the structures.
 3. Safe passageways shall be provided for the public around the demolition area and operations conducted to prevent damage to adjacent buildings, structures, other facilities, and people.
 4. Sidewalks, utilities, and streets, adjacent to the work, shall not settle or be left in a dangerous condition, as a result of the demolition operations. The submittals required in Article 1.2 above shall clearly show how this requirement shall be satisfied. Calculations and details which substantiate adequacy of the method proposed to fulfill this requirement shall be submitted.
 5. Where special procedures are required such as barriers, flaggers, safety devices, insurance for work around the railroad tracks, temporary disconnection of utility

services, and detouring or restricting vehicular traffic, the work shall be performed in accordance with such requirements and in accordance with this article.

6. Utilities shall be maintained, supported, and restored in accordance with the appropriate sections.
7. Protection of Property
 - a. Protect all public and private property, insofar as it may be endangered by operations and take every reasonable precaution to avoid damage to such property.
 - b. Restore and bear the cost of any public or private improvement facility, structure or land and landscaping which is damaged or injured directly or indirectly by or on account of an act, omission, or neglect in the execution of the work. Restore to a condition substantially equivalent to that existing before such damage or injury occurred, by repairing, rebuilding, or otherwise affecting restoration thereof, or if this is not feasible, make a suitable settlement with the owner of the damaged property.
 - c. Give reasonable notice to occupants of buildings on property adjacent to the work to permit the occupants to remove vehicles, trailers and other possessions as well as salvage or relocate plants, trees, fences, sprinkler systems, or other improvements in the right-of-way, or permanent or temporary construction easements, which are designated for removal or which might be destroyed or damaged by work operations.
 - d. Protect all trees, lawns and planted areas within the right-of-way or easements. Restore all on-surface disturbed areas, by seeding, mulching and providing erosion control as set forth in Section 02276 (Temporary Erosion Control), and, if conditions are such that seeding cannot be done, provide erosion control surface covering of such quality and quantity as will prevent erosion from occurring, without adverse impacts to the environment, at no additional cost to the KCMO.
 - e. In existing parkway, strips or landscape areas, where asphalt or compacted earth are indicated on the Contract Drawings for removal and replacement, they shall be replaced with material similar to that removed in thickness, type and appearance.
 - f. The Engineer shall be notified immediately if any suspected hazardous or contaminated materials are encountered.
8. Existing signage, if not identified for removal, shall be protected in place. If, in the way of the work, the sign shall be relocated to a location approved by the Engineer.

PART II - PRODUCTS - NOT USED

PART III - EXECUTION

3.1 PREPARATION

- A. All required protection and safety measures, protective and regulatory devices and personnel shall be in place before demolition commences.
- B. Ingress and egress requirements shall be maintained. The work shall be performed in a manner to cause as little inconvenience to the public as possible.

3.2 DEMOLITION

- A. Where an abutting structure or a part of a structure is to be left in place, clean, smooth, vertical cuts shall be made with a saw or other approved cutting device to lines established or as directed. The part that is left shall be structurally sound and stable, and shall not present a hazard or attractive nuisance to members of the public or Contractor employees.
- B. Removal of pavements, sidewalks, curbs, foundations, and other structures shall extend to the limits shown on the Contract Drawings or the construction limits. Removal beyond these limits must be approved by the Engineer.
- C. Removal of existing pavements shall be removed to the base of the paving material.
- D. Replacement of pavements, sidewalks, curbs and other structures beyond the Contract limits shall not be paid for, and shall be completed at the Contractor's expense unless approved by the Engineer.
- E. Removal of concrete pavement shall be completed by saw cutting to a minimum of 4 inches at the limits as shown on the Contract Drawings and jack hammering to a size needed for excavation and removal.
- F. The Contractor may salvage materials from demolition for use in temporary facilities but these shall not be used in the work unless approved in writing by the Engineer in each specific case.

3.3 DISPOSAL

- A. Unless otherwise stipulated, all materials resulting from the removal of obstructions shall become the property of the Contractor at the place of origin and shall be disposed of by the Contractor in conformance with all laws, regulations and rules legally imposed on such activities.
- B. Materials shall not be disposed of on publicly-owned or publicly-controlled lands except by written permission of the Engineer and, if so permitted, the materials shall be placed only at such locations and in such manner as the Engineer may direct.
- C. Asphalt concrete and Portland cement concrete pavement which is removed shall become the property of the Contractor at the place of origin and shall be disposed of by the Contractor in conformance with all laws, regulations, and rules legally imposed on such activities.
- D. The Contractor is encouraged to separate asphalt pavement and provide to sites for use in recycled asphalt pavement preparation.
- E. Trees, shrubs and plants to be removed shall become the property of the Contractor, and shall be disposed of in accordance with local codes and ordinances.
- F. The Contractor is encouraged to use recycling as a method of disposal whenever possible.

- G. Fences located within the limits of work that are still remaining when the Notice to Proceed (NTP) is issued will become the property of the Contractor. The Contractor will dispose of the materials in accordance with applicable codes and regulations. Prior to the removal of existing fencing, the Contractor shall provide temporary fencing to protect and contain or exclude animals and to provide security to the existing properties. Temporary fencing will be in accordance with Section 02831, Fencing and Gates.

3.4 REPAIRS

Items to remain which are damaged during demolition shall be repaired or replaced as directed by the Engineer at no cost to KCMO.

3.5 REMOVAL OF EXISTING FACILITIES AND MISCELLANEOUS MATERIALS

- A. Removal of existing walks, curbs, walls, driveways, and similar Portland cement concrete structures shall conform to the requirements of this Section. Cuts at structures and pavements to remain shall be clean, smooth and vertical.
- B. All cast iron utility valve and manhole rims and covers not reused by the Project shall be removed and stockpiled by the Contractor at a location to be determined by the Engineer. Each item that is salvaged for stockpiling shall be identified with an attached tag citing the location from which it was removed.
- C. The Contractor shall remove and relocate or salvage existing street lights as shown in the Plans, or as designated by the Engineer.

3.6 ABANDONMENT OF SEWER STRUCTURES AND CONDUITS

Sewer manholes, inlets, pipes, and similar structures shall be removed or abandoned as indicated on the Contract Drawings and specified herein.

Removed pipes and structures shall be removed in entirety with backfill of removed pipes conforming to Sections 02221 (Trench Excavation and Backfill) and Section 02225 (Embankment, Excavation and Backfill Compaction).

Remaining ends of abandoned pipes, or portions of other items partially removed under this work which would be left exposed on side slopes or at subgrade, shall be removed to a minimum of two feet below the finished slope or finished grade and filled with common embankment. Common embankment material shall conform to the requirements of Section 02225.

For pipes that are encountered in the field, which are not shown on the Contract Drawings, and have been proven by the Contractor to be no longer in service, the Contractor shall use the following general criteria as outlined in the Table below to determine if the pipe shall be removed or abandoned. For pipes encountered in the field, the Contractor shall inform the Engineer of the pipe and location. The Contractor shall indicate the course of action for the subject pipe and shall obtain approval and/or confirmation from the Engineer prior to removal and/or abandonment of the pipe.

Existing Pipe Depth (below subgrade to top of existing pipe)	Pipe <= 24 IN diam.	24 < pipe <= 36 IN	Pipe > 36 IN
0 – 4 FT	REMOVE	REMOVE	REMOVE
4 – 6 FT	ABANDON	REMOVE	REMOVE

6 – 8 FT	ABANDON	ABANDON	REMOVE
> 8 FT	ABANDON	ABANDON	ABANDON

Pipes that are to be abandoned as specified in the Table will be required to remain in place, and therefore are not required to be filled and / or plugged as outlined in the Contract Drawings and specified herein.

3.7 REMOVAL OF SIGNS

The Contractor shall remove and relocate existing traffic signs and similar items as indicated on the Contract Drawings. The Contractor shall deliver signs to a location determined by the Engineer.

3.8 EXISTING FACILITIES

Disturbed or damaged existing facilities and appurtenances that are to remain in service upon completion of the Contract shall be cleaned up and restored.

3.9 MATERIALS

1. Unless otherwise stipulated, all materials resulting from the removal of obstructions shall become the property of the Contractor at the place of origin and shall be disposed of by the Contractor in conformance with all laws, regulations and rules legally imposed on such activities.
2. Materials shall not be disposed of on publicly-owned or publicly-controlled lands except by written permission of the Engineer and, if so permitted, the materials shall be placed only at such locations and in such manner as the Engineer may direct.

PART IV – MEASUREMENT

This work will not be measured for payment, but will be considered a lump sum unit. The work will include the demolition and removal of structures as required, regardless of whether the items are shown on the plans or encountered during construction, unless the presence of the improvement encountered could not have been determined by visual inspection prior to bidding. No deductions will be made from the quantities measured for payment of excavation where existing improvements are removed from within the limits of the sections measured for determining pay quantities of excavation.

PART V – PAYMENT

Accepted removal of improvements will be paid for at the contract lump sum price.

END OF SECTION

SECTION 02 41 00**DEMOLITION DISPOSAL****PART 1 – GENERAL****A. Disposal of Demolition Debris**

All demolition debris not to be salvaged shall be disposed of at a legal landfill or at some other site where dumping of such materials is allowed under federal, state and local laws. Such site must be previously approved in writing by the OWNER.

B. Approved Dumpsites

In Kansas City, demolition debris dumpsites are permitted by the Board of Zoning Adjustment. For further information on City approved dumpsites contact:

Michelle Disanto
City Planner
City Development
15th Floor, City Hall
414 East 12th Street
Kansas City, Missouri 64106
Tel: 816-513-2851
Fax: 816-513-2838

C. Earthen Landfills

Soil, rock, and gravel are not considered to be demolition debris and can be placed at properly permitted locations. Obtain grading permits, erosion control permits, and floodplain certificates as applicable (from OWNER).

D. Submittals

At the pre-construction conference, CONTRACTOR shall submit the proposed sites for disposal of demolition debris and earthen material, in writing, to the OWNER. Once work starts, all substitute sites shall be submitted in writing to the OWNER. Submittals shall include a copy of the permit authorizing disposal at each site whether in or out of the City/County Limits.

OWNER'S REPRESENTATIVE will confirm that the proposed sites, both within and out the City/County Limits, are properly authorized. OWNER'S REPRESENTATIVE will advise CONTRACTOR in writing if a disposal site is not properly authorized. Lack of a response to inquiry is sufficient cause to reject a disposal site.

E. Remedy

Failure to abide by these contract requirements to use only approved dumpsites, whether intentional or inadvertent, is deemed to be a major violation of the contract. In the event of such violation, the OWNER shall have two special remedies, in addition to local ordinance penalties. It may, at its sole option:

1. Direct that the materials which have been dumped at a site other than the approved one be moved to the approved location, and that the site where the unapproved dumping took place to be restored to its previous condition, or
2. Terminate the contract immediately by written notice to the CONTRACTOR, in which case the CONTRACTOR shall have no right to cure its default. The CONTRACTOR shall be entitled to be paid for the completed portion of his contract less the expense to remedy the unauthorized dumping. Such payment shall be made only after the work is complete and all costs are finally determined.

Before either of such remedies is invoked, the CONTRACTOR will be given five (5) Working Days written notice of the alleged violation. During the five (5) day period, the contractor may submit information for consideration by the OWNER. Due to the nature of illegal dumping, OWNER need not have proof positive; "alleged" is herewith adjudged sufficient evidence to terminate this contract.

PART 2 – PRODUCTS

None

PART 3 – EXECUTION

None

PART 4 – MEASUREMENT

None

PART 5 – PAYMENT

No separate payment will be made for “Demolition Disposal”. All costs pertaining thereto shall be included in the contract prices for other items as listed in the Bid Form of Unit Prices.

END OF SECTION

SECTION 02 41 13**REMOVAL OF IMPROVEMENTS****PART 1 – GENERAL**

This work shall consist of removing and disposing of all existing improvements for roadway contracts from the right of way and within the limits of any construction easement outside the right of way, except improvements designated to remain in place or to be under other items of work.

Removal of improvements shall include removing, as listed in the plan set, drainage structures, pavement, surfacing and base courses, curb, gutter, sidewalks, driveways, house walks, steps, retaining walls, catch basins, manholes, drainage and sewer pipes, water and gas main pipes, signs, fences, scattered or piled bricks, stones, broken masonry, rubbish, trees, debris, outdoor advertising signs, etc. from existing improvements.

The plans may not show a complete list of all items to be removed. There may be an undetermined number of abandoned utilities, or other improvements encountered. The CONTRACTOR shall determine the extent of the work to be performed under this item.

Related specifications sections include:

- Section 02 41 00 - Demolition Disposal
- Section 03 81 13 - Saw Cutting
- Section 31 13 00 - Tree Removal
- Section 31 13 16 - Tree Root Pruning

Additional reference include "Section 02100 - Grading and Site Preparation" of the American Public Works Association (APWA) as supplemented by Kansas City, Missouri, in most current edition.

The CONTRACTOR shall perform the work in accordance with the State of Missouri and City of Kansas City Public Work's standards.

PART 2 – PRODUCTS

None

PART 3 – EXECUTION

None

PART 4 – MEASUREMENT

This work will not be measured for payment, but will be considered a lump sum unit. The work will include the removal of all items, regardless of whether the items are shown on the plans or encountered during construction, unless the presence of the improvement encountered could not have been determined by visual inspection prior to bidding. No deductions will be made from the quantities measured for payment of excavation where existing improvements are removed from within the limits of the sections measured for determining pay quantities of excavation.

PART 5 – PAYMENT

Accepted removal of improvements will be paid for at the contract lump sum price.

END OF SECTION

SECTION 03 08 16
CONCRETE TESTING AND EVALUATION - CONTRACTOR

PART 1 - GENERAL**1.1 SUMMARY**

- A. Furnish labor, materials, tools, equipment, and services for Concrete Testing and Evaluation - Contractor, as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.
- C. Test concrete materials and operations and inspect as work progresses. Failure to detect defective work or material shall not prevent later rejection when such defect is discovered nor shall it obligate Architect/Engineer for final acceptance.

1.2 QUALITY ASSURANCE

- A. ASTM International (ASTM):
 - 1. ASTM C31 Standard Practice for Making and Curing Concrete Test Specimens in Field.
 - 2. ASTM C39 Standard test Method for Compressive Strength of Cylindrical Concrete Specimens.
 - 3. ASTM C42 Standard test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
 - 4. ASTM C 138 Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete
 - 5. ASTM C143 Standard test method for Test for Slump of Hydraulic Cement Concrete.
 - 6. ASTM C172 Standard Practice for Sampling Freshly Mixed Concrete.
 - 7. ASTM C173 Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
 - 8. ASTM C231 Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
 - 9. ASTM C1064 Standard Test Method for Temperature of Freshly Mixed Hydraulic - Cement Concrete
 - 10. ASTM E329 Standard Specification for Agencies Engaged in Construction Inspection and/or Testing
- B. American Concrete Institute (ACI):
 - 1. ACI 318 Building Code requirements for Structural Concrete and Commentary
- C. Testing Agency:
 - 1. Acceptable to Architect.
 - 2. Recent evidence of inspection by Cement and Concrete Reference Laboratory of National Institute of Standards and Technology, with cited deficiencies corrected.
 - 3. Meet requirements of ASTM E 329.
 - 4. Agency and its representatives are not authorized to revoke, alter, relax, enlarge or release requirements, nor approve or accept portion of Contract Documents.

1.3 SUBMITTALS

- A. Project information:
 - 1. Testing Agency qualifications.
 - 2. Production sample test reports:
 - a. Include same data as required for mix design reports.

3. Reports of Contractor-optional tests.
4. Test reports for in-place testing, if such testing is performed.

PART 2 - PRODUCTS - NOT USED

PART 3 - EXECUTION

3.1 DESCRIPTION - GENERAL

- A. Test concrete materials and inspect operations as work progresses.
- B. Failure to detect defective work or material shall not prevent later rejection when such defect is discovered nor shall it obligate Architect for final acceptance.
- C. Following testing services shall be performed by testing agency:
 1. Review and check-test Contractor's proposed materials for compliance with specifications.
 2. Review and check-test Contractor's proposed mix design.
 3. Secure production samples of materials at plants or stock-piles during course of work and test for compliance with specifications.
 4. Conduct strength tests of concrete during construction in accordance with following procedures:
 - a. Secure composite samples in accordance with ASTM C172.
 - 1) Obtain each sample from a different batch of concrete on a random basis.
 - 2) Select test batch at random before commencement of concrete placement.
 - b. Mold and cure sufficient specimens from samples in accordance with ASTM C31.
 - 1) Report deviations from requirements.
 - c. Test specimens in accordance with ASTM C39.
 - 1) Test two specimens at 28 days for acceptance and one at 7 days for information.
 - 2) Acceptance test results shall be average of strengths of two specimens tested at 28 days.
 - d. If one specimen in a test manifests evidence of improper sampling, molding or testing, discard; strength of remaining cylinder shall be considered test result.
 - 1) Should both specimens in a test indicate above defects, discard entire test.
 - e. Make at least one strength test for each 75 CU YD or fraction thereof, of each mix design of concrete placed in one day.
 - 1) When total quantity of concrete with a given mix design is less than 15 CU YD, strength tests may be waived by Architect.
 5. Determine slump of concrete for each strength test and whenever consistency of concrete appears to vary, in accordance with ASTM C143.
 6. Determine density, unit weight, of concrete for each strength test in accordance with ASTM C138.
 7. Determine air content of normal weight concrete for each strength test in accordance with ASTM C231
 8. Determine air content of lightweight concrete for each strength test in accordance with ASTM C173 .
 9. Determine temperature of concrete in accordance with ASTM C1064 for each strength test.

3.2 ADDITIONAL TESTING SERVICES

- A. Following non-routine services shall be performed on occasions indicated:
 1. Additional testing and inspection, whenever changes in materials or proportions are requested by Contractor.

2. Additional testing of materials or concrete when they fail by test or inspection, to meet specification requirements.
3. Other testing services needed or required by Contractor, such as:
 - a. Field cured test specimens for determining when concrete may be post-tensioned or when forming shoring or reshoring may be removed.

3.3 DUTIES AND AUTHORITIES OF DESIGNATED TESTING AGENCY

- A. Inspect, sample and test materials and production of concrete. When it appears that material furnished or work performed by Contractor fails to fulfill specification requirements, report such deficiency to Architect/Engineer and Contractor.
- B. Report test and inspection results to Architect and Contractor immediately after performed. Include exact location in work at which batch represented by a test was deposited.
 1. Reports shall include detailed information on storage and curing of specimens prior to testing.
- C. Agency and its representatives are not authorized to alter requirements of Contract Documents, nor to approve or accept any portion of work.

3.4 RESPONSIBILITIES AND DUTIES OF CONTRACTOR

- A. Provide testing services for qualification of proposed materials and establishment of mix designs.
- B. Use of testing service shall not relieve Contractor of responsibility to furnish materials and construction in full compliance with Contract Documents.
- C. Submit concrete materials and concrete mix designs, with results of testing performed to qualify materials and to establish mix designs.
 1. Do not place concrete until Contractor has received approval in writing.
- D. Testing and Inspection:
 1. Furnish labor to assist Testing Agency in obtaining and handling samples or other materials at site.
 2. Advise Testing Agency in advance of operations.
 3. Provide and maintain facilities for storage and curing of concrete test specimens on site for first 24 HRS or until sufficient strength is achieved as required by ASTM C31.

3.5 EVALUATION AND ACCEPTANCE OF COMPRESSIVE STRENGTH TEST RESULTS

- A. Evaluate test results for standard molded and cured test cylinders separately for each concrete mix design.
 1. Evaluate each mix design for strength and uniformity by a minimum of five tests.
- B. Strength level of concrete shall be considered acceptable when average of three consecutive strength test sets equal or exceed specified strength (f'c) and no individual strength test result is less than specified strength (f'c) by more than 500 PSI.

3.6 TESTING IN-PLACE CONCRETE

- A. Test concrete in place when compressive strength tests indicate potential strength deficiency to evaluate actual strength.
 1. Pay for concrete tests and engineering time and analysis required to evaluate actual in-place concrete strength made necessary by low strength cylinder tests.
- B. Testing by rebound hammer, ultrasonic, or other non-destructive device:
 1. Tests shall be used to determine relative strengths at various locations in structure as an aid for selecting areas to be cored.

2. Tests, unless properly calibrated and correlated with other test data, will not be used as a basis for acceptance or rejection.
- C. Core tests:
1. Obtain and test largest practical diameter cores, 2 IN minimum, in accordance with ASTM C42.
 - a. Test dry if concrete in structure will be dry under service conditions,
 - 1) Air dry cores at 60 DegF to 80 DegF, relative humidity less than 60 percent for 7 days before test.
 - b. Test cores after moisture conditioning if concrete in structure is more than superficially wet under service conditions.
 2. Take three cores from area of concrete or member considered deficient in strength.
 - a. Location as selected by Architect.
 - b. Replace cores damaged prior or during removal from structure prior to testing.
 3. Concrete core test shall be considered acceptable if average strength of cores is equal to at least 85 percent of, with no single core less than 75 percent of specified strength (f'c).
 4. Fill core holes with low slump patching compound per Section 03 35 00.

3.7 ACCEPTANCE OR REJECTION OF IN-PLACE CONCRETE

- A. General:
1. Completed concrete work which conforms to requirements of Contract Documents will be accepted without qualification.
 2. Concrete work which fails to conform to one or more requirements of Contract Documents shall be rejected and will not be accepted until repaired and proven adequate by concrete testing.
 3. Remedial work includes, but is not necessarily limited to, applicable repairs, replacement, reinforcement, engineering, and testing.
 4. Repair or replacement of concrete in an approved manner and in conformance with Contract Documents constitutes acceptance.
- B. Dimensional tolerances:
1. Formed surfaces resulting in concrete outlines smaller than permitted by tolerances shall be considered potentially deficient in strength and subject to confirmation of safety by structural analysis or load test.
 - a. When deficiencies are confirmed, replace or reinforce structure as directed.
 2. Formed surfaces resulting in concrete outlines larger than permitted by tolerances will be rejected if strength or finish of structure is not acceptable, or function is adversely affected.
 - a. If removal of excess material is permitted, repair of surfaces constitutes acceptance.
 - b. If removal of excess material is not permitted, replacement of surfaces constitute acceptance.
 3. Concrete members cast in wrong location will be rejected if: strength or finish is not acceptable, function is adversely affected, and /or interference is encountered with other construction.
 4. Inaccurately formed concrete surfaces exceeding tolerances and exposed to view will be rejected.
 5. Finished slabs exceeding tolerances may be repaired provided that strength or appearance is not adversely affected. High spots may be removed with a terrazzo grinder, low spots filled with a patching compound, or other remedial measures performed as permitted.
- C. Finish:
1. Architectural concrete with surface exceeding limitations will be rejected.
 2. Concrete exposed to view with defects which adversely affect appearance of specified finish may be repaired only by approved methods.

3. Slabs:
 - a. Finished slabs exceeding tolerance limits specified in Section 03 35 00 will be rejected if finish is not acceptable and function is adversely affected.
 - 1) If rejected, repair of finished surfaces or replacement of slab in an approved manner and in conformance with Contract Documents will constitute acceptance.
 - b. Repair may involve removing high spots by grinding, filling low spots with patching compound, or remedial measures as permitted.
 4. Formed surfaces:
 - a. Concrete exposed to view with defects which adversely affect appearance of specified finish will be rejected.
 - 1) Repair surface defects in conformance with Section 03 35 00.
 5. Concrete not exposed to view is not subject to rejection for defective finish.
- D. Strength of structure:
1. Concrete in place which control strength of structure will be rejected if it fails to comply with requirements of Contract Documents, including but not necessarily limited to:
 - a. Deficient concrete strength based on compressive strength tests.
 - b. Reinforcing steel size, quantity, strength, position, or arrangement at variance with requirements on reinforcement.
 - c. Concrete which differs from required dimensions or location.
 - d. Curing less than that specified.
 - e. Inadequate protection of concrete from extremes of temperature during early stages of hardening and strength development.
 - f. Mechanical injury, construction fires, accidents or premature removal of formwork.
 - g. Substandard workmanship.
 2. When strength of structure is considered potentially deficient, it will not be accepted until one of following is completed and submitted to Architect for approval prior to action by Contractor.
 - a. Confirmation of safety of structure by structural analysis.
 - b. Core tests shall be performed only when safety of structure is not confirmed by structural analysis.
 - c. Confirmation of safety of structure by load tests performed and evaluated in accordance with ACI 318.
 - d. Replacement of structure deficient in strength.
 - e. Reinforce structure with supplement supports as directed by Architect and approved by Owner.

END OF SECTION

SECTION 03 11 00
CONCRETE FORMWORK

PART 1- GENERAL**1.1 SUMMARY**

- A. Furnish labor, materials, tools, equipment, and services for Concrete Formwork, as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

- A. Design, engineering, and construction of formwork are responsibility of Contractor.
 - 1. Design, engineer, and construct formwork for applicable gravity and lateral loads and pressures as well as other design considerations or applicable requirements of legal local building code.
 - 2. Develop shoring and re-shoring pattern and sequence so as not to exceed safe structural capacity of supporting structural systems. Confer with Architect, if there is any question, regarding the capacity of the structural system.
- B. Design, prepare formwork drawings and construct formwork in accordance with ACI 347, Guide to Formwork for Concrete.
- C. Layout and measurement of concrete forms and embedment's, required for work, performed by a licensed surveyor employed by the contractor.

1.3 SUBMITTALS**1.4 DESCRIPTION**

- A. Definitions:
 - 1. Formwork: Total system of support for freshly placed concrete including mold or sheathing which contacts concrete as well as supporting members, hardware, and necessary bracing.
 - 2. Exposed construction: Exposed to view.
 - 3. Exposed to view: Concrete surfaces seen by the public from eye level from any walking surface in a public location after completion of building.
 - 4. Public location: Building areas accessible to public and employees not responsible for maintenance. Storerooms, unfinished space and large mechanical rooms are considered public locations. Equipment closets, elevator and mechanical penthouses are not public space.
- B. Use forms, wherever necessary, to confine concrete and shape it to required dimensions. Use forms of sufficient strength to withstand pressure resulting from placement and vibration of concrete, with sufficient rigidity to maintain specified tolerances.
- C. See concrete finish requirements in Section 03 35 00.
- D. Use earth side forms for spread footings, pile caps and unfinished grade beams where earth can be shaped to a straight and true surface. Do not use earth cuts as forms for other vertical surfaces unless permitted.

PART 2 - MATERIALS**2.1 MATERIALS**

- A. Form facing materials: As indicated under description of finishes required.
- B. Form accessories, partially or wholly embedded in concrete, such as ties and hangers: Shall be of a commercially manufactured type. Do not use non-fabricated wire. Use form ties constructed so ends or end fasteners can be removed without causing appreciable spalling of concrete faces. After ends or end fasteners of form ties have been removed, embedded portion of ties shall terminate not less than 2 diameters or twice minimum dimension of tie from formed faces of concrete to be permanently exposed to view, but in no case less than 3/4 IN. When formed face of concrete is not to be permanently exposed to view, form ties may be cut off flush with formed surfaces. Use ties with 3/4 IN diameter cones on both ends for water retaining structures.

2.2 FABRICATION OF FORMS

- A. Make forms sufficiently tight to prevent loss of cement fines. Place chamfer strips in outside corners of forms to produce 45 degree beveled corners on permanently exposed surfaces. Interior corners on such surfaces and edges of formed joints will not require beveling.
- B. To maintain specified finish tolerances, camber formwork to compensate for anticipated formwork deflections prior to hardening of concrete.
- C. Provide positive means of adjustment (wedges or jacks) of shores and struts and take up settlement during concrete placing operation. Securely brace forms against lateral deflection.
- D. Provide temporary openings at base of column and wall forms and at other points where necessary to facilitate cleaning and observation immediately before concrete is placed.
- E. At construction joints, contact surface of form sheathing for flush surfaces exposed to view shall overlap hardened concrete in previous placement minimum 1 IN. Hold forms against hardened concrete to prevent offsets or loss of mortar at construction joint and to maintain a true surface.
- F. Construct wood forms for wall openings to facilitate loosening, if necessary, to counteract swelling.
- G. Fasten wedges (used for final adjustment of forms prior to concrete placement) in position after final check.
- H. Anchor formwork to shores or other supporting surfaces or members so upward or lateral movement of any part of formwork system is prevented during concrete placement.
- I. Provide runways for moving equipment with struts or legs, supported directly on formwork or structural member without resting on reinforcing steel.

2.3 TOLERANCES

- A. Construct formwork so concrete surfaces will conform to tolerance limits listed: Tolerances non-cumulative. Most restrictive tolerance governs. Tolerance limits noted are maximum deviations (plus or minus) on each side of intended line.
 - 1. Deviation from plumb:
 - a. In lines and surfaces of columns, piers, walls, and in arrises:
 - 1) In any length: 1 in 500 but not less than 1/8 IN.
 - 2) In any story: 3/8 IN.
 - 3) Maximum for entire length: 3/4 IN.
 - b. For exposed corner columns, control-joint grooves, and other conspicuous vertical lines:
 - 1) In any length: 1 in 1000 but not less than 1/8 IN.
 - 2) In any story: 3/16 IN.

- 3) Maximum for entire length: 1/2 IN.
 2. Deviation from level or from grades specified:
 - a. In slab soffits, ceilings, beam soffits and in arrises, measured before removal of supporting shores:
 - 1) In any length: 1 in 750 but not less than 1/8 IN.
 - 2) In any bay: 3/8 IN.
 - 3) Maximum for entire length: 1/2 IN.
 - b. In exposed lintels, sills, parapets, horizontal grooves, and other conspicuous horizontal lines:
 - 1) In any length: 1 in 1000, but not less than 1/8 IN.
 - 2) In any bay: 1/4 IN.
 - 3) Maximum for entire length: 1/2 IN.
 3. Deviations from true plane of concrete surface exposed to view caused by bulging of form facing material between supports:
 - a. 3/16 IN or 1/300 of span between supports whichever is smaller.
 4. Deviation from established position in plan of linear building lines, columns, walls:
 - a. In any length: 1 in 500, but not less than 1/8 IN.
 - b. In any bay: 1/2 IN.
 - c. Maximum for entire length: 3/4 IN.
 5. Deviation in sizes and location of sleeves, floor openings, and wall openings: 1/4 IN.
 6. Deviation in cross-sectional dimensions of columns and beams and in thickness of slabs and walls:
 - a. Minus: 1/4 IN.
 - b. Plus: 1/2 IN.
 7. Footings:
 - a. Deviations in dimensions in plan:
 - 1) Minus: 1/2 IN.
 - 2) Plus: 2 IN.
 - b. Misplacement or eccentricity:
 - 1) 2 percent of footing width in direction of misplacement but not more than 2 IN.
 - c. Thickness:
 - 1) Decrease in specified thickness: 5 percent.
 - 2) Increase in specified thickness: No limit (except that which may interfere with other construction).
 8. Deviation in steps:
 - a. In flight of stairs:
 - 1) Rise: 1/8 IN.
 - 2) Tread: 1/4 IN.
 - b. In consecutive steps:
 - 1) Rise: 1/16 IN.
 - 2) Tread: 1/8 IN.
 - c. Deviation from level for any step or landing: 1 in 1000 but not more than 1/8 IN.
- B. Formwork Classifications:
1. Concrete formwork shall meet the following classification requirements:
 - a. Concrete noted as "Architectural Exposed Concrete: Class A."
 - b. Concrete exposed to view or to receive membrane waterproofing: Class B.
 - c. Footings: Class D.
 - d. All other concrete: Class C.
- C. Tolerances apply to concrete dimensions only, not to positioning of vertical reinforcing steel, dowels, or embedded items, except where specifically noted otherwise.

- D. Establish and maintain in undisturbed condition and until final completion of project, sufficient control points and bench marks to be used for reference purposes to check tolerances.
- E. Regardless of tolerances listed allow no portion of building to extend beyond property line of project.

PART 3 - EXECUTION

3.1 PREPARATION OF FORM SURFACES

- A. Clean form surfaces and embedded materials of mortar, grout and foreign material before concrete is placed.
- B. Unless otherwise specified or approved, treat surfaces of forms as follows:
 - 1. Before placing of reinforcing steel or concrete, cover surfaces of forms with coating material that will effectively prevent absorption of moisture and prevent bond with concrete, and not stain concrete. A field applied form release agent or sealer or factory applied non-absorptive liner may be used.
 - 2. Do not allow excess form coating material to stand in puddles in forms nor in contact with hardened concrete against which fresh concrete is to be placed.

3.2 REMOVAL OF FORMS

- A. When repair of surface defects or finishing is required at early age, remove forms as soon as concrete has hardened sufficiently to resist damage from removal operations.
- B. Remove top forms on sloping surfaces of concrete as soon as concrete has attained sufficient stiffness to prevent sagging. Perform needed repairs or treatment required on such sloping surfaces at once, followed by specified curing.
- C. Loosen wood forms for wall openings as soon as this can be accomplished without damage to concrete.
- D. Formwork for columns, walls, sides of beams, and other parts not supporting weight of concrete may be removed as soon as concrete has hardened sufficiently to resist damage from removal.
- E. Where no re-shoring is planned, leave forms and shoring used to support weight of concrete in beams, slabs and other concrete members in place until concrete has attained its specified strength. Where re-shoring is planned, supporting formwork may be removed when concrete has reached 70 percent of specified strength, provided re-shoring is installed immediately.
- F. When shores and other vertical supports are arranged so non-load-carrying form-facing material may be removed without loosening or disturbing shores and supports, facing material may be removed at earlier age as permitted.

3.3 RE-SHORING

- A. When re-shoring is permitted or required, plan operations in advance. Follow sequence indicated on formwork drawings as as directed by forming system design engineer. While re-shoring is underway, allow no live load on new construction.
- B. During re-shoring do not subject concrete in beam, slab, column or other structural member to combined dead and construction loads in excess of loads permitted by forming system design engineer for developed concrete strength at time of re-shoring. Place re-shores as soon as practicable after stripping operations are complete but in no case later than end of working day on which stripping occurs. Tighten re-shores to carry required loads without overstressing construction. Leave re-shores in place until:
 - 1. Tests representative of concrete being supported have reached specified strength.

2. In-place concrete is at least 7 days old and/or meets the strength required by the forming system design engineer.
 3. Loads imposed by construction operations do not exceed design loads.
- C. For floors supporting shores under newly placed concrete leave original supporting shores in place or re-shore. Re-shoring system shall have capacity sufficient to resist anticipated loads and equal to at least one half of capacity of shoring system above. Locate re-shores directly under shore position above unless otherwise permitted.
- D. In multi-story buildings extend re-shoring over sufficient number of stories to distribute weight of newly placed concrete, forms, and construction live loads in such a manner that capacity of floors as determined by design load and developed concrete strength at time of stripping and re-shoring is not exceeded.

3.4 REMOVAL STRENGTH

- A. When removal of formwork or re-shoring is based on concrete reaching specified strength, concrete shall be presumed to have reached this strength when either of following conditions has been met.
1. When test cylinders, field cured along with concrete they represent, have reached specified strength.
 2. When concrete has been cured as specified for same length of time as age at test date of laboratory-cured cylinders which reached specified strength. Determine length of time concrete has been cured in structure by cumulative number of days or fractions thereof, not necessarily consecutive, during which temperature of air in contact with concrete is above 50 degF and concrete has been damp or sealed from evaporation and loss of moisture.

END OF SECTION

SECTION 03 11 10**CONCRETE FORMWORK****PART I - GENERAL****1.1 SUMMARY**

- A. Description: This work includes furnishing, installing and removal of concrete formwork as specified.

1.2 REFERENCES

- A. ACI 347: Guide to Formwork for Concrete

1.3 DEFINITIONS

- A. Shoring: The activity to support formwork.
- B. Reshoring: The activity to reduce the amount of formwork supporting concrete elements. As concrete sets and strength increases, less need for formwork occurs gradually until concrete becomes free standing.

1.4 SUBMITTALS

- A. Shop Drawings: Fabrication and erection drawings of forms for specific finished concrete surfaces, as indicated. Show general construction of forms, jointing, special joints or reveals, location and pattern of form tie placement, and other items affecting exposed concrete visibility.
- B. Form Release Agent: Where concrete surfaces are scheduled to receive special finishes or applied coverings which may be affected by agent submit manufacturer's instructions for use of agent.

1.5 QUALITY ASSURANCE

- A. Designer's Qualifications: Design of forms for shoring or for high risk situations will be signed by a Missouri licensed engineer. Other formwork, i.e. SOG and Box walls may be by Contractor staff.
- B. Design Forms:
 - 1. With sufficient strength to maintain finished tolerances indicated in Section 03 35 10, to support loads, pressures, and allowable stresses as outlined in ACI 347 and for design considerations such as wind loads, allowable stresses, and other applicable requirements of local Laws and Regulations.
 - 2. To permit easy removal.
 - 3. For required finishes.
- C. The design, engineering, and construction of formwork is Contractor's responsibility.

1.6 JOB CONDITIONS

- A. For reference purposes, establish and maintain sufficient control points and bench marks to check tolerances. Maintain in an undisturbed condition and until final completion and acceptance of Work.
- B. Regardless of tolerances specified, allow no portion of Work to extend beyond legal boundaries.

1.7 FIELD SAMPLES

- A. Prepare field samples and submit as required in the Project Quality Plan.
- B. Construct and erect sample formwork panel for architectural concrete surfaces receiving special treatment or finish as a result of formwork. Formwork to include vertical and horizontal form joints and typical rustication joints when required.
- C. Size panel to indicate special treatment or finish required, including form release agent.
- D. Remove formwork after casting concrete.

PART II - PRODUCTS

2.1 FORM MATERIALS

- A. Faced with material which will produce smooth and uniform texture on concrete, unless indicated otherwise.
- B. Arrange facing material orderly and symmetrical, keeping number of seams to a minimum.
- C. Do not use material with raised grain, patches, or other defects which will impair texture of concrete surface.

2.2 FORMWORK ACCESSORIES

- A. Form Ties:
 - 1. Use ties constructed so that end fasteners can be removed without spalling concrete faces.
 - 2. After end fasteners of ties have been removed, embedded portion of ties are to terminate not less than 2 times the diameter or thickness of the fasteners from formed faces of concrete, but in no case greater than 3/4-inch.
 - 3. When the formed face on concrete is not exposed, form ties may be cut off flush with formed surfaces. Use ties with 3/4-inch diameter cones on both ends or an approved equal for water retaining structures.
- B. Premolded Expansion Joint Filler: Unless indicated otherwise, provide Type F1 per APWA Section 03060.
- C. Form Release Agent: Colorless material which will not stain concrete, absorb moisture, impair natural bonding or color characteristics of concrete.
- D. Fillets for Chamfered Corners: Wood strips 3/4 inch x 3/4 inch size; maximum possible length.

PART III - EXECUTION**3.1 INSPECTION**

- A. Verify lines, levels, and measurements before proceeding with formwork.

3.2 FORM CONSTRUCTION

- A. Make forms sufficiently tight to prevent loss of concrete.
- B. Unless indicated otherwise, place chamfer strips in corners of forms to produce beveled edges on permanently exposed exterior corners.
- C. To maintain specified finish tolerances, camber formwork to compensate for anticipated deflections.
- D. Provide positive means of adjustment using wedges, jacks, shores, and struts to take up all settlement during concrete placing operation.
- E. Provide temporary ports in formwork to facilitate cleaning and inspection. Locate openings at bottom of forms to allow flushing water to drain.
- F. At construction joints, overlap forms over hardened concrete at least 6-inches. Hold forms against hardened concrete to prevent offsets or loss of mortar at construction joint and to maintain true surface.
- G. Construct wood forms for wall openings to facilitate loosening, or counteract swelling.
- H. Fasten wedges used for final adjustment of forms prior to concrete placement in position after final check.
- I. Anchor formwork to shores, supporting surfaces or members to prevent upward or lateral movement and deflection of any part of formwork system during concrete placement.
- J. Provide runways for moving equipment with struts or legs, supported directly on formwork or structural member without resting on reinforcing.
- K. Position expansion joint material and other embedded items accurately and support to prevent displacement.
- L. To prevent entry of concrete, fill voids in sleeves, inserts, and anchor slots temporarily with readily removable material.
- M. For architectural concrete, limit deflection of facing materials between studs as well as deflection of studs and walers to 0.0025 times span.
- N. For underground concrete work, do not use soil walls for forming unless authorized by Engineer.

3.3 INSERTS, EMBEDDED PARTS, AND OPENINGS

- A. Provide formed openings for elements embedded in or passing through concrete.
- B. Coordinate work of other sections for the forming and setting of openings, slots, recesses, chases, sleeves, bolts, anchors, and other inserts.

- C. Install accessories per manufacturer's instructions. Ensure items are not disturbed during concrete placement.

3.4 FORM FINISHES

- A. Use forms with smooth rubbed, scrubbed, sand floated finishes that meet ACI 347 unless indicated otherwise.
- B. For As-cast Finishes:
 - 1. Install form panels in orderly arrangement with joints planned in approved relation to building elements.
 - 2. Where panel joints are recessed or otherwise emphasized, locate form ties within joints, not within panel areas.
 - 3. Where an as-cast finish is required, no grouting will be permitted in the finishing operation.
- C. Textured Finishes: As indicated.

3.5 APPLICATION OF FORM RELEASE AGENT

- A. Apply form release agent on formwork per manufacturer's instructions. Apply prior to placing reinforcing steel, anchoring devices, and embedded items.

3.6 FORM REMOVAL

- A. When repair of surface defects or finishing is required at an early age, remove forms as soon as concrete has hardened sufficiently to resist damage from removal operations.
- B. Remove top forms on sloping surfaces of concrete as soon as concrete has attained sufficient stiffness to prevent sagging. Perform needed repairs or treatment required on such sloping surfaces at once, followed by specified curing.
- C. Loosen wood forms for wall openings as soon as it can be accomplished without damage to concrete.
- D. Formwork for columns, walls, sides of beams, and other members not supporting the weight of concrete may be removed as soon as the concrete has hardened sufficiently to resist damage from removal.
- E. Where no reshoring is planned, leave forms and shoring used to support weight of concrete in beams, slabs, and other concrete members in place until concrete has attained its specified strength.
- F. Where reshoring is planned, supporting formwork may be removed when concrete has reached 70-percent of specified strength, provided reshoring is installed immediately.
- G. When shores and other vertical supports are so arranged that nonload carrying, form-facing material may be removed without loosening or disturbing shores and supports, facing material may be removed at an earlier age as directed.

3.7 RESHORING

- A. When reshoring is permitted or required, plan operations in advance and obtain approval.
- B. During reshoring do not subject concrete in beam, slab, column, or any other structural member to combined dead and construction loads and live loads in excess of loads permitted for developed concrete strength at time of reshoring.
- C. Place reshores as soon as practical after stripping operations are complete, but in no case later than end of working day on which stripping occurs.
- D. Tighten reshores to carry required loads without over-stressing.
- E. Leave reshores in place until the concrete being supported has reached its specified strength.
- F. For floors supporting shores under newly placed concrete, level original supporting shore or reshore.
 - 1. Reshoring system shall have a capacity to resist anticipated loads in all cases equal to at least 1/2 the capacity of the shoring system.
 - 2. Unless otherwise specified locate reshores directly under a shore.
 - 3. In multistory buildings, extend reshoring through a sufficient number of stories to distribute the weight of newly placed concrete, forms, and construction live loads in such a manner that design loads of floors and supporting shores are not exceeded.

3.8 REMOVAL STRENGTH

- A. When removal of formwork or reshoring is based on concrete reaching a specified strength, it shall be assumed that concrete has reached this strength when either of the following conditions has been met:
 - 1. When test cylinders, field cured along with the concrete they represent, have reached the specified strength.
 - 2. When concrete has been cured per Section 03 39 00 for the same length of time as the site-cured cylinders that reached specified strength. Determine the length of time the concrete has been cured in the structure by cumulative number of days or fractions thereof, not necessarily consecutive, during which the air temperature is above 50 deg. F. and concrete has been damp or sealed from evaporation and loss of moisture.

3.9 REUSE OF FORMS

- A. Do not reuse forms if there is any evidence of surface wear or defect which would impair quality of concrete surface.
- B. Thoroughly clean and properly coat forms before reuse.

3.10 FIELD QUALITY CONTROL

- A. Before commencing a pour, verify connections, form alignment, ties, inserts and shoring

are placed and secure.

- B. Observe formwork continuously while concrete is being placed to verify that the forms are plumb and there are no deviations from desired elevation, alignment, or camber.
- C. If during construction any weakness develops and false-work shows undue settlement or discoloration, stop work, remove affected construction if permanently damaged, and strengthen false-work.

PART IV - MEASUREMENT

4.1 Measurement – No Separate measurement will be made for Work described in this Section.

PART V - PAYMENT

5.1 Payment – Payment for items in this Section will be incidental to the Contract unit cost of the concrete bid items.

END OF SECTION

SECTION 03 15 10**CONCRETE FLATWORK****PART I - GENERAL****1.1 SUMMARY**

- A. Description: This Section covers the work required to furnish materials and construct concrete flatwork as shown on the Contract Drawings. The work includes grade preparation, setting forms, placing untreated base course, pouring concrete, finishing, and curing of concrete.

1.2 SUBMITTALS

- A. Submittals shall be made in accordance with the requirements of the General Provisions of the Specifications, except as modified herein.

1.3 QUALITY ASSURANCE/QUALITY CONTROL

- A. Quality assurance/quality control shall be performed in accordance with the requirements of the Project Quality Plan, except as modified herein.

PART II - PRODUCTS**2.1 CONCRETE**

- A. Class AA (AE) concrete as specified in Section 03 15 16, Article 3.2, Table 3.
- B. Use high purity, chemically inert, unfading, and alkali-free synthetic pigment coloring material.

2.2 EMBANKMENT MATERIAL

- A. Material shall be in compliance with the requirements stipulated in Section 31 22 00 of the Specifications.

2.3 AGGREGATE BASE COURSE

- A. Material shall be in compliance with the requirements stipulated in Section 32 11 00 of the Specifications.

2.4 FORMS

- A. Concrete forms shall be in accordance with the requirements stipulated in Section 03 11 10 of the Specifications.

2.5 CONCRETE PLACING, FINISHING, AND CURING

- A. Concrete placing, finishing and curing shall be in accordance with the requirements stipulated in Sections 03 30 00, 03 35 10, and 03 39 00 of the Specifications.

PART III - EXECUTION

3.1 STANDARD PROCEDURES

- A. Construct subgrade to the elevations as specified on the Contract Drawings. Subgrade shall be constructed in accordance with the requirements stipulated in Section 31 23 13 of the Specifications.
- B. Place and compact fill material in accordance with the requirements stipulated in Section 31 22 00 of the Specifications.

PART IV - MEASUREMENT

- 4.1 Measurement** – No Separate measurement will be made for Work described in this Section.

PART V - PAYMENT

- 5.1 Payment** – Payment for items in this Section will be incidental to the Contract unit cost of the concrete bid items.

END OF SECTION

SECTION 03 15 16**PORTLAND CEMENT CONCRETE****PART I - GENERAL****1.1 SUMMARY**

- A. Description: The Work in this Section includes the materials and procedures for producing Portland Cement concrete for construction of concrete structures, pre-stressed concrete, precast concrete, and cast-in-place concrete, including footings, foundations, pier columns, pier caps, bridge girders, retaining walls, MSE, and miscellaneous concrete structures as shown on the Contract Drawings.

1.2 REFERENCED STANDARDS

<u>Sponsor</u>	<u>Number</u>	<u>Subject</u>
AASHTO	M 6	Fine Aggregate for Portland Cement Concrete
AASHTO	M 80	Coarse Aggregate for Portland Cement Concrete
AASHTO	M 157	Ready Mixed Concrete
AASHTO	T 26	Quality of Water to be Used in Concrete
ACI	301	Standard Specification for Structural Concrete
ACI	305R	Hot Weather Concreting
ACI	306R	Cold Weather Concreting
ASTM	C 31	Making and Curing Concrete Test Specimens in the Field
ASTM	C33	Concrete Aggregates
ASTM	C 39	Compressive Strength of Cylindrical Concrete
ASTM	C 136	Sieve Analysis of Fine and Coarse Aggregates
ASTM	C 138	Density (Unit Weight), Yield and Air Content of Concrete
ASTM	C 150	Portland Cement
ASTM	C 172	Sampling Freshly Mixed Concrete
ASTM	C 231	Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM	C 260	Air-Entraining Admixtures for Concrete Specimens
ASTM	C 494	Chemical Admixtures for Concrete
ASTM	C 595	Blended Hydraulic Cement

ASTM	C 618	Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete
ASTM	C 1157	Blended Hydraulic Cement
ASTM	C 1240	Silica Fume for Use as a Mineral Admixture in Hydraulic-Cement Concrete, Mortar, and Grout
ASTM	C 1260	Potential Alkali Reactivity of Aggregates (Mortar-bar Method)
ASTM	E 11	Wire-Cloth Sieves for Testing Purposes

1.3 SUBMITTALS

- A. Mix design: Submit
1. Date of mix design. If mix design is older than 290 days on day of submittal, the mix design must be recertified. Submit the mix design 10 days prior to use.
 2. Source and type of cement and its percentage of expansion.
 3. Physical properties of coarse, fine and combined aggregate.
 4. Average concrete strength (f_c') per quality control chart.
 5. Size of coarse aggregate.
 6. Allowable range of slump and air content.
 7. Water/cement ratio.
 8. Proportions of materials in the mix.
 9. Unit weight.
 10. Analysis of water to be used unless potable.
 11. Technical data sheets for additives to be used at the plant and at the job site. Certify additives are compatible with each other.
- B. Pre-approved mix design, submit name and address of supplier.
- C. Before changing mix design submit a new mix design and give Engineer 10 days to evaluate the changes.
- D. Quality Control Report: Upon Engineer request, submit a written quality control inspections and testing report describing source quality control activities performed by Contractor and Contractor suppliers.

1.4 QUALITY ASSURANCE

- A. Reject concrete that does not meet requirements of this section.

- B. Do not change material sources, type of cement, air-entraining agent, water reducing agent, other admixtures except as allowed by mix design.
- C. Store bagged and bulk cement in weatherproof enclosures. Exclude moisture and contaminants.
- D. Prevent segregation and contamination of stockpiled aggregate.
- E. Avoid contamination, evaporation, or damage to admixtures. Protect liquid admixtures from freezing.
- F. Use of admixtures will not relax hot or cold weather placement requirements.

PART II - PRODUCTS

2.1 CEMENT

- A. Use Portland Cement conforming to ASTM C150, Type I/II, low alkali for concrete, unless otherwise specified.
- B. Do not use different brands or different types of cement or the same brand of cement from different mills without prior written approval of the Engineer.
- C. Do not use cement that contains lumps or is partially set.
- D. Do not use air-entrained cement.
- E. Cement may be sampled and tested for compliance at any time by the Engineer.

2.2 COARSE AGGREGATE

- A. As specified in AASHTO M 80, and as modified, using one of the gradations found in Table 1.

Table 1

Aggregate Gradations - Percent Passing (by weight)									
Aggregate Size (in)	2.5 in	2 in	1.5 in	1 in	$\frac{3}{4}$ in	$\frac{1}{2}$ in	$\frac{3}{8}$ in	$\frac{3}{16}$ in	
2 to $\frac{3}{16}$	100	95-100		35-70		10-30		0-5	
1.5 to $\frac{3}{16}$		100	95-100		35-70		10-30	0-5	
1 to $\frac{3}{16}$			100	95-100		25-60		0-10	
$\frac{3}{4}$ to $\frac{3}{16}$				100	90-100		20-55	0-10	

- B. Use sieve screens with square openings as specified. Meet ASTM E 11.
- C. Do not exceed percentages of deleterious substances as shown in AASHTO M 80, Table 1, for Class A aggregates.

- D. Determine the suitability of coarse aggregate sources using the requirements for soundness, percentage of wear and potential reactivity as specified in AASHTO M 80.

2.3 FINE AGGREGATE

- A. As specified using the gradation shown in Table 2. Meet AASHTO M 6.

Table 2

Sieve Size	Percent Passing (by weight)
$\frac{3}{8}$ in	100
$\frac{3}{16}$ in	95 to 100
#16	45 to 80
#50	10 to 30
#100	2 to 10

- B. Do not exceed percentages of deleterious substances as outlined in AASHTO M 6 for class A aggregates.
- C. Soundness: As specified to determine suitability of fine aggregate, meet AASHTO M 6.

2.4 COMBINED AGGREGATE

Do not allow the material passing the #200 sieve to exceed 1.75 percent by weight of the combined fine and coarse aggregates.

2.5 WATER

- A. Potable, or water that meets the specified test standard in AASHTO T 26.
- B. Screen out extraneous material when pumping water from streams, ponds, lakes, etc.

2.6 ADMIXTURES

- A. Air Entrainment: as specified, meet ASTM C260, including Section 5.
- B. Water Reducing Agents: as specified, meet ASTM C 494.
1. The chlorides content (as Cl⁻) not exceeding 1 percent by weight of the admixtures.
- C. Do not use calcium chloride.
- D. Protect all admixtures from freezing.

2.7 POZZOLAN

- A. Fly Ash:
1. Class F, as specified.
 - a. Conform to ASTM C 618, Class F.
 - b. Loss on Ignition (LOI): not to exceed 3 percent.

- c. Maximum allowable CaO content: not to exceed 15 percent.
 2. Allowed as a Portland cement replacement under the following conditions:
 - a. If used, replace 15 to 20 percent of the Portland cement by weight.
 - b. Use the minimum cement content in the design formulas before replacement is made.
 - c. Label the storage silo for fly ash to distinguish it from cement.
 - d. Use different size unloading hoses and fittings for cement and fly ash.
- B. Natural Pozzolan (Class N)
 1. Conform to ASTM C 618.
 2. May use instead of fly ash provided that the 14-day expansion test (ASTM C 1260) with job aggregates and job cement does not exceed that for the same aggregates and cement with a MoDOT approved Class F fly ash.
- C. Silica Fume: Conform to ASTM C 1240. Use 5% silica fume in all bridge decks by weight of all cementitious materials.

PART III - EXECUTION

3.1 PREPARATION

- A. Aggregate stockpiles:
 1. Clear, grub, smooth, and compact the site.
 2. Stockpile platforms will be constructed in such a way as to prevent intrusion of subgrade materials into aggregates.
 3. Building stockpiles at least two days before use.
 4. Provide an operator and front-end loader to help the Engineer take aggregate samples.
 5. Acceptance will be made in daily increments, but not more than 30 days before use.
 6. Provide separate stockpiles for coarse and fine aggregate.
 7. Construct stockpiles in thin layers (5 ft maximum) that have uniform thickness and a regular form.
 - a. Do not build high, cone-shaped piles above the maximum height of 10 ft before distribution.
 - b. Do not dump or spill aggregate over the sides of the stockpile.
 - c. Minimize segregation of aggregate.
 8. Allow washed aggregates to drain to a uniform moisture content before use (12 hours minimum).

9. Move conveyor continuously across the stockpile as aggregate is discharged.
 10. Do not drop material more than 10 ft from conveyor.
- B. Heating Aggregate and Water
1. Provide and operate heating devices when heated aggregates are required.
 2. Aggregates must be free of ice.
 3. Heat aggregates uniformly, when required. Avoid overheating or developing hot spots.
 4. Meet temperature control requirements found in Subsection 3.7.
 5. Meet cold weather limitations in Subsection 3.8.
 6. Use either steam or dry heat.
 7. Do not allow the products of fuel combustion to contact the aggregate.
 8. Heat the mixing water to between 70 degrees F and 180 degrees F when introduced into the mixer.

3.2 CONCRETE CLASSES AND MIX REQUIREMENTS

- A. Meet the requirements in Table 3.

Table 3

Concrete Classes and Mix Requirements							
Class	Coarse Aggregate Size (in)	Max. Water/Cement Ratio	Min. Cement Content (lbs/cu yd)	Slump (in)	Air Content Percent (%)	Mix Design Compress f'_{cr} (ksi)	28 Day Minimum Compress f'_c (ksi)
6A(AE)	**	**	**	**	**	10.5	8.0
5A(AE)	**	**	**	**	**	9.0	7.0
4A(AE)	**	**	**	**	**	7.8	6.0
3A(AE)	**	**	**	**	**	6.5	5.0
AA(AE)	2 to $\frac{3}{16}$	0.44	565	1 - 3.5	4.0 - 7.0	5.2	4.0
	1.5 to $\frac{3}{16}$	0.44	565	1 - 3.5	4.5 - 7.5	5.2	4.0
	1 to $\frac{3}{16}$	0.44	611	1 - 3.5	5.0 - 7.5	5.2	4.0
	$\frac{3}{4}$ to $\frac{3}{16}$	0.44	611	1 - 3.5	5.0 - 7.5	5.2	4.0
	1.5 to $\frac{3}{16}$	0.53	470	1 - 3.5	4.5-7.5	3.9	3.0

A(AE)	1 to $\frac{3}{16}$	0.53	470	1 - 3.5	4.5-7.5	3.9	3.0
	$\frac{3}{4}$ to $\frac{3}{16}$	0.48	517	1 - 3.5	4.5-7.5	3.9	3.0
B or B(AE)		0.62	376	2 - 5	-- 3.0-6.0	3.25	2.5
C or C(AE)		0.70	376	2 - 5	-- 3.0-6.0	2.6	2.0

** Design and proportion mixes according to ACI 301 and project specific criteria.

- B. Minimum strength is based on a coefficient of variation of 10 percent, and one test below the minimum strength per 100 tests.
- C. Maximum size of coarse aggregate:
1. Not larger than $\frac{1}{5}$ of the narrowest dimension between sides of forms.
 2. Not larger than $\frac{1}{3}$ the depth of slabs.
 3. Not larger than $\frac{3}{4}$ of the minimum clear distance between reinforcing bars or between bars and forms, whichever is least.
- D. Do not exceed water/cement ratio.
- E. When a pozzolan is used in the mix, calculate the water/cement ratio (w/c) according to the following formula:

$$\frac{W}{C} = \frac{\text{Water}}{\text{Cement} + \text{pozzolan}}$$

- F. When using water reducing admixtures, use the following slump requirements.
1. Slump requirements when using low range water reducers: 1 to 6 in for all classes of concrete.
 2. Slump requirements when using high range water reducers: 4 to 9 in for all classes of concrete.

3.3 ADDITIONAL REQUIREMENTS FOR USING HIGH RANGE WATER REDUCERS (SUPER PLASTICIZERS)

- A. Establish the effective life of the High Range Water Reducer (HRWR) by trial batch.
1. Trial batch will approximate field conditions including time of placement (see Subsection 3.7.A), and concrete temperature.
 2. Engineer may witness the trial batch.
 3. Slowly agitate the mix throughout the test period.

4. Record and plot slump and mix temperature at 15 minimum intervals.
 5. Maintain the required slump (4 in. to 9. in) throughout the time allowed for placement. Re-dose if necessary.
 6. If re-dosing is required, record the time of re-dose and the amount of admixture added.
 7. Do not exceed any manufacturer's recommendations for the use of the HRWR.
- B. High Range Water Reducer (HRWR) may be added at the job site.
1. Record on the batch ticket, the time at which the HRWR was added.
 2. Maintain the mixing period for truck mixers between 70 and 100 revolutions at mixing speed.
 3. Engineer may perform a standard slump test before adding the HRWR to a transit mixer.
 4. Engineer may take additional slump tests at the job site after adding the HRWR.
- C. If the HRWR is added to a central mixer, no preliminary slump test is required.
- D. Show on batch tickets the amount of admixture used.
- E. Do not exceed the requirements established by the trial batch.
- F. The Contractor is responsible for changes in placement and finishing operations due to the addition of admixtures.

3.4 ADDITIONAL REQUIREMENTS FOR USING SET RETARDING ADMIXTURES

- A. If set retarding admixtures are specified due to haul times exceeding the time limitations in Subsection 3.7.A, establish the effective life of the set retarding admixture by trial batch.
1. The trial batch will approximate field conditions including concrete mix temperature.
 2. Engineer may witness the trial batch.
 3. Slowly agitate the mix throughout the test period.
 4. Record and plot slump and mix temperature at 15-minute intervals.
 5. Do not exceed any manufacturers recommendations for the use of the set retarding admixture.
 6. Do not re-dose the concrete with additional set retarding admixture.
- B. Add set retarding admixture at the batch plant at the time of initial batching operations, or immediately after.
- C. Show on batch tickets the amount of admixture used.
- D. Time of placement will be established by the trial batch and will supersede the time requirements in Subsection 3.7.

- E. Do not exceed the requirements established by the trial batch.
- F. The Contractor is responsible for changes in placement and finishing operations due to the addition of admixtures.

3.5 BATCHING MATERIALS

- A. Meet AASHTO M 157.
- B. Meet the requirements of the MoDOT Quality Management Plan for Ready-Mix Concrete.
- C. Operate the batch mixer at the manufacturer's recommended drum speed.
- D. Keep drums and blades free from excessive cement and mortar buildup.
- E. Add the admixtures separately to the mix water.
- F. Do not use any process that will cause "flash set" of the mix.
- G. At central mix plants, mix all materials for at least 80 seconds at recommended drum speed.
 - 1. When adding more water or cement, mix 30 additional seconds.
 - 2. Introduce the cement into the batcher before the fly ash.
- H. Conduct mixing efficiency tests as specified.
 - 1. AASHTO M 157, Annex A-1.
 - 2. The Contract shall order mixing efficiency tests at the beginning of concrete operations, or anytime deemed necessary by Contractors QA staff or Engineer.
- I. Maintain the mixing period for truck mixers between 70 and 100 revolutions at mixing speed.
 - 1. Maintain a minimum of 90 revolutions for front-end discharge trucks.
 - 2. Complete concrete mixing before the truck leaves the batch plant yard.
- J. Hand Mixing:
 - 1. Only Class B and C concrete may be hand mixed.
 - 2. Hand-mixed batches cannot exceed 0.5 yd³ in volume.
 - 3. Hand mix on a watertight platform.
 - 4. Spread the aggregate evenly on the platform, and thoroughly mix in the dry cement until the mixture becomes uniform in color.

3.6 TRANSPORTING

- A. Transport ready-mixed concrete in transit mixers or agitator trucks.
 - 1. Do not load trucks in excess of their rated mixing capacity, or 63 percent of the drum gross volume, or less than 2.0 yd³.

2. The truck rating plate must be readable.
- B. Equip transit mixers or agitator trucks with a visible water meter and revolution counter (electronic or mechanical). Use the water meter to measure all water discharged from the truck's tank.
- C. Obtain approval to add water after the transit mixer or agitator truck leaves the batch plant.
1. Add water within the specified time limits.
 2. Do not add more water than the batch ticket indicates.
 3. Do not add water after more than 0.5 yd³ of concrete has been discharged from the drum and do not exceed the water/cement ratio.
 4. When adding water, rotate the drum at least 30 revolutions at the mixing speed recommended by the manufacturer.

3.7 LIMITATIONS - GENERAL

- A. Reject concrete if:
1. Mix temperature is less than 50 degrees F.
 2. It is not placed within 90 minutes when the air temperature is below 90 degrees F.
 3. It is not placed within 90 minutes after the addition of cement to the aggregates when the mix temperature is between 80 and 85 degrees F.
 4. It is not placed within 45 minutes after mix temperature rises to between 86 and 90 degrees F.
 5. Mix temperature is greater than 90 degrees F.
 6. Initial set has developed.
 7. Revolutions of drum or blades not to exceed 300 (per ASTM C94 and AASHTO M197).
- B. Do not temper concrete by adding water or by any other means after initial set or false set has taken place.
- C. Pumping and Conveying Equipment
1. Do not use equipment, or a combination of equipment and the configuration of that equipment, that causes a loss of entrained air content that exceeds one half of the range of air content allowed by specification.
 2. Contractor is responsible for verification and/or monitoring of air loss.

3.8 LIMITATIONS - COLD WEATHER (ACI 306R)

- A. Cold weather limitations apply when the temperature is likely to fall below 40 degrees F within 14 days of placement.

- B. Comply with the following regulations for placing concrete in cold weather:
1. Submit a written plan for approval 14 calendar days before concrete placement.
 2. Do not use chemical additives in the concrete to prevent freezing.
 3. Provide all necessary cold weather protection for in-place concrete (cover, insulation, heat, etc.).
 4. Do not place concrete in contact with frozen surfaces.
 5. Produce concrete with a temperature between 60 degrees F and 90 degrees F at the time of placing.
 6. Adequately vent combustion-type heaters that produce carbon monoxide.
 7. Maintain the concrete temperature above 50 degrees F for the first 14 days after placing.
 8. Protect the concrete from freezing until a compressive strength of at least 3.5 ksi has been achieved.
 9. Maintain moist conditions for exposed concrete not in contact with forms; avoid loss of moisture from the concrete due to heat applied.
 10. Limit the drop in temperature next to the concrete surfaces when removing heat to 52 degrees F during any 12-hour period until the surface temperature of the concrete reaches that of the atmosphere.
 11. Determine the concrete temperature with a surface thermometer insulated from surrounding air.
- C. Paving:
1. Paving may begin when base surface temperature is 36 degrees F in the shade and ascending.
 2. Maintain the mix temperature at a minimum 60 degrees F.
 3. Cease operations when the ambient temperature is 45 degrees F in the shade and decreasing.
 4. Do not add chemical admixtures to prevent freezing.
 5. Remove and replace concrete damaged by frost action.
 6. Do not use material containing frost or lumps.
 7. Do not heat water or aggregate to more than 150 degrees F.
 8. Protect the concrete from freezing until a compressive strength of at least 3.5 ksi has been achieved.

3.9 LIMITATIONS - HOT WEATHER (ACI 305R)

- A. Begin batching operations when the ambient air temperature in the shade is 84 degrees F and declining.
- B. Discontinue placing when the ambient air temperature reaches 80 degrees F in the shade and is increasing.
- C. Paving: Discontinue paving when mix temperature reaches 90 degrees F either at point of placement or batch plant platform, or when ambient air temperature exceeds 100 degrees F in the shade.

3.10 LIMITATIONS-SURFACE EVAPORATION

- A. Surface evaporation limitations apply and may occur at any time of the year, when any combination of air temperature, relative humidity, and wind velocity, that have the potential to impair the quality of fresh or hardened concrete or otherwise result in abnormal properties. Submit a written plan for approval 14 calendar days before concrete placement that shows proper attention will be given to ingredients, production methods, handling, placing, protection, and curing to prevent excessive concrete temperatures and water evaporation that could impair strength or serviceability of the concrete. Refer to ACI 305R.
- B. The surface evaporation plan may include any of the following actions:
 - 1. Construct windbreaks or enclosures to effectively reduce the wind velocity throughout the area of placement.
 - 2. Use fog sprayers upwind of the placement operations to effectively increase the relative humidity.
 - 3. Reduce the temperature of the concrete by shading the material storage area or production equipment, cool aggregate by sprinkling, cool aggregate and/or water by refrigeration or by replacing a portion or all of the mix water with flaked or crushed ice to the extent that the ice will completely melt during mixing of the concrete.
 - 4. Adjustment of the placement schedule.
 - 5. Use of an approved water-based mono-molecular polymer liquid evaporative reducer at application rates recommended by the manufacturer. Not to be used as a finishing aid.

3.11 FIELD QUALITY CONTROL - SAMPLING

- A. The Contractor shall conduct sampling and testing.
 - 1. When testing concrete from a concrete pump, the Contractor shall take the samples from the hose after all of the priming grout has been wasted.
- B. Provide and maintain cylinder storage devices to control the temperature within the specified range.
 - 1. Maintain cylinders at a temperature range of 50 degrees F to 80 degrees F for the initial 16-hour curing period.
 - 2. Do not move the cylinders during this period.

3. Equip the storage device with an automatic 24-hour temperature recorder with an accuracy of ± 2 degree F.
 4. Have the storage devices available at the point of placement at least 24 hours before placement.
 5. The Contractor shall stop placement of concrete if the storage device cannot accommodate the required number of test cylinders.
 6. Use water containing hydrated lime if water is to be in contact with cylinders.
 7. A 24-hour test run may be required.
- C. Protect cylinders for evaluating in-place strength of concrete prior to applying loads or stresses.
1. Store specimens at or near the structure
 2. Locate specimens where their temperature will be approximately that of the concrete in the structure.
 3. Leave specimens at the structure for as long a period of time as possible before shipping to the laboratory.
 4. Keep specimens in a plywood box (without insulation) and in a shaded location.
 5. Avoid conditions of extreme exposure to wind and sun as well as over protection from weather variations.
 6. Place specimens in field curing location as soon as possible after they are fabricated without disturbing the concrete while in its plastic state.
 7. The curing location must be a firm level surface, free from vibration and otherwise protected from disturbance.
 8. Cure all test specimens with the axis of the cylinder vertical.
- D. Do not place concrete without inspector's approval.

PART IV - MEASUREMENT

4.1 Measurement – No Separate measurement will be made for Work described in this Section.

PART V - PAYMENT

5.1 Payment – Payment for items in this Section will be incidental to the Contract unit cost of the concrete bid items.

END OF SECTION

SECTION 03 15 23
EXPANSION JOINT SEALS IN CONCRETE

PART 1 - GENERAL**1.1 SUMMARY**

- A. Furnish all labor, materials, tools, equipment, and services for Expansion Joint Seals In Concrete, as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

- A. Install Expansion Joints in weather-tight, water-tight fashion.
- B. Extruded Neoprene:
 - 1. Quality complying with ASTM D 3542, and the following properties:

Minimum Physical Properties		
Property	Test Method	Required Value
Tensile strength, min.	ASTM D 412	3447 kPa 2000 PSI
Elongation at break, min.	ASTM D 412	250 percent
Hardness, Type A durometer	ASTM D 2240	55 ±5
Oven aging (70 hours at 100 degC 212 degF): Tensile strength, max. Elongation, max. Hardness, Type A durometer	ASTM D 573	20% loss 20% loss 0 to +10 pts
Max Weight Change due to Oil swell; (#3 Oil for 70 hours at 100 degC 212 degF)	ASTM D 471	45 percent
Ozone resistance, 20 percent strain 70 hours aging, ASTM D 573, 3 ppm in air	ASTM D 1149	No cracks

1.3 SUBMITTALS

- A. Project Information:
 - 1. Manufacturer of listed products.
- B. Contract Closeout Information:
 - 1. Flood Test Results.

PART 2 - PRODUCTS**2.1 ACCEPTABLE MANUFACTURERS**

- A. Expansion joint seals:
 - 1. Base:
 - a. D.S. Brown.
 - 2. Optional:
 - a. Watson Bowman Acme Corp
- B. Other manufacturers desiring approval comply with Section 00 26 00.

2.2 MATERIALS

- A. General:

1. Size material for joint width(s) indicated and in accord with current published recommendations of manufacturer.
 2. Use maximum available lengths.
 3. Use factory fabricated joints.
 4. Use types described below where indicated:
- B. Expansion Joint Seal – Type A:
1. Description:
 - a. Elastomeric, neoprene profiles as indicated.
 2. Base Product(s) (refer to plans for where occurs):
 - a. “JP-Series” by D.S. Brown.
- C. Expansion Joint Seals – Type D (Normal-duty Compression Type):
1. Description:
 - a. Elastomeric, neoprene honeycomb profiles as indicated.
 - b. Width(s): As indicated
 2. Base Product:
 - a. “CS-Series” by D.S. Brown.
- D. Lubricant/adhesive:
1. High-strength, 2-part Epoxy Manufacturer’s standard.
 2. Use where required.

2.3 EXPANSION JOINTS TYPES SPECIFIED ELSEWHERE

- A. Expansion Joints at Roofing:
1. Specified in Section 07 62 00 and applicable roofing section(s), or both.
- B. Expansion Joints in Exterior Walls:
1. See Compressible Sealants, Specified in Section 07 92 13.
- C. Expansion Joints in Interior locations:
1. Specified in Section 07 95 13.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Assure that joints to receive seal are free from defects with sides straight and parallel to proper width and depth indicated.
1. Temperature at time of joint construction determines width of working joint.
 2. Form joints allowing for design temperature variations.
 3. Ensure that concrete is cured per manufacturer’s recommendations, prior to installing joint.

3.2 PREPARATION

- A. Clean surfaces to receive seal of material which may be detrimental to effective joint sealing.
- B. Do not apply adhesives at temperatures below 5 DegC 40 DegF.
- C. Do not install seals at temperatures above 30 DegC 85 DegF.
- D. Keep adhesives and solvents away from heat or flame.
- E. Apply in well ventilated area.

3.3 INSTALLATION

- A. General:
1. Where pedestrian traffic is anticipated: Utilize material which are ADA compliant.

2. Miter and splice seal at corners where space does not permit a smooth bend.
 3. Splice seal using adhesive to provide a permanent, watertight joint.
 4. Remove misapplied adhesive immediately, using methylethyl ketone (MEK) or toluene.
- B. Installation – Joint Type A, C, and D:
1. Decompress seals using vacuum suction.
 2. Apply continuous coat of adhesive to both joint interfaces immediately prior to seal installation.
 3. Insert into joint void.
 4. Release suction, allowing material to expand and apply necessary bonding pressure.
 - a. Exception: Use pressurized air, in lieu of suction, where so recommended by manufacturer.
 5. Install with top recessed 3mm 1/8 IN.
- C. Installation – Joint Type B:
1. Embed stainless steel frame rails into concrete.
 2. Coordinate joint void width with drawings and according to manufacturer's recommendations.
 3. Install substantially flush with adjacent slab surfaces.
 4. Seal frame rails to concrete after slabs have cured.

3.4 FIELD TESTING

- A. Flood test installed joints for 24 hours.
1. Minimum depth of water: 50mm 2 IN.
- B. Visually inspect area below for signs of water leakage.
- C. Repair areas which permit passage of water and re-test.

END OF SECTION

SECTION 03 20 00 CONCRETE REINFORCING

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish all labor, materials, tools, equipment, and services for Concrete Reinforcing, as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

- A. Testing of reinforcing steel welding shall be performed by Owner's testing agency at Owner's expense.
- B. Standards:
 - 1. ASTM-A185: Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete Reinforcement.
 - 2. ASTM A663: Standard Specification for Steel Bars, Carbon, Merchant Quality, Mechanical Properties.
 - 3. ASTM-A615: Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
 - 4. ASTM-A675: Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality, Mechanical Properties.
 - 5. ASTM-A706: Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement.
 - 6. ASTM-A775: Standard Specification for Epoxy-Coated Reinforcing Steel Bars.
 - 7. ASTM-A884: Standard Specification for Epoxy-Coated Wire and Welded Wire Reinforcement.
 - 8. ACI 315: Details and Detailing Concrete Reinforcement.
 - 9. American Welding Society ANSI/AWS-D1.4 Structural Welding Code- Reinforcing Steel.
- C. Initial test for reinforcing bar welding will be paid by Owner. Retests due to failed initial tests shall be paid by Contractor.

1.3 SUBMITTALS

- A. Shop Drawings:
 - 1. Shop drawings indicating size, number, dimensions and locations of reinforcing steel and accessories, in sufficient detail to permit installation of reinforcing without reference to Contract drawings.
 - a. Details of concrete reinforcement and accessories not indicated on Contract Documents shall be in accordance with ACI 315.
- B. Project Information:
 - 1. Certification that reinforcing to be welded conforms to ASTM-A706.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. End bearing splice couplers:
 - 1. Base:

- a. Erico Products.
- B. Tension splice couplers:
 - 1. Base:
 - a. Erico Products.
 - b. Dayton Metal Products.
 - c. Dextra America Inc.
- C. Epoxy adhesive for anchoring reinforcing:
 - 1. Base:
 - a. Hilti, HIT System.
- D. Other manufacturers desiring approval comply with Section 00 26 00.

2.2 MATERIALS

- A. Reinforcing - General: Conform to ASTM-A615, Grade-60.
- B. Reinforcing - Welded: Reinforcing to be welded shall conform to ASTM-A706.
- C. Welded wire reinforcement: Flat sheets conforming to ASTM-A185 and to wire size and spacing of smooth wire indicated on drawings.
- D. Smooth dowel bars for construction joints: Conform to ASTM-A663 or ASTM-A675, Grade-60. Where indicated, provide a metal dowel cap at one end of dowel to permit longitudinal movement of dowel within concrete section. Provide for movement which equals joint width plus 13 mm 1/2 IN. Unless otherwise indicated, use 16 mm 5/8 IN diameter dowels spaced 455 mm 18 IN on center.
- E. Slab on Grade Plate Dowels: May be used as an equal substitute for smooth dowel bars at construction joints. Plate material shall be ASTM A36 steel and shall be Diamond Dowel System, by PNA Construction Technologies, size 1/4" x 4 1/2 " dowels or equal . Locate plate dowels per smooth dowel bar requirements. Do not shear plates. Remove burrs at edges of plates.
- F. End bearing splice couplers:
 - 1. Erico Speed-Sleeve Splice by Erico Products.
- G. Tension splice couplers: Shall develop minimum 125 percent of yield strength of bar(s). Where drawings indicate tension splice couplers, provide one of following:
 - 1. "Lenton" threaded tension coupler by Erico Products.
 - 2. "Bar-Grip" tension coupler by Dayton Metal Products of Miamisburg, OH.
 - 3. "Cadweld" tension splice by Erico Products.
 - 4. Bar-Lock lockshear bolt coupling sleeves, manufactured by Dayton Superior
 - 5. "Bartec" Mechanical Couplers as manufactured by Dextra America, Inc.
- H. Epoxy coating for reinforcing: Conform to ASTM-A775. Coat reinforcing specifically noted on drawings as well as applicable splice couplers. Touch up damaged coating areas in field.
- I. Epoxy anchored reinforcing: Install reinforcing anchored in concrete with epoxy adhesive, in accordance with epoxy manufacturer's instructions.

2.3 FABRICATION

- A. Bars used for concrete reinforcement shall meet following requirements for fabricating tolerances:
 - 1. Sheared length: Plus or minus 25 mm 1 IN.
 - 2. Depth of truss bars: Plus 0, minus 13 mm 1/2 IN.
 - 3. Overall dimensions of stirrups, ties, and spirals: Plus or minus 13 mm 1/2 IN.
 - 4. Other bends: Plus or minus 25 mm 1 IN.

- B. For bars with "End Bearing Splice Couplers," bar ends shall terminate in flat surfaces, within 1-1/2 degrees of a right angle to axis of bars and shall be fitted within 3 degrees of full bearing after assembly.

PART 3 - EXECUTION

3.1 WELDING

- A. Perform welding of reinforcing steel in conformance with AWS-D1.4.
- B. Use E70 electrodes.
- C. Each welder shall place an approved identifying mark near each completed weld.
- D. Cut out welds determined to be defective and reweld and retest at Contractor's expense.

3.2 PLACING REINFORCEMENT

- A. Provide minimum concrete covering for reinforcement as follows:
 - 1. Concrete deposited against earth: 75 mm 3 IN.
 - 2. Formed surfaces exposed to weather or in contact with earth: 50 mm 2 IN for reinforcing bars No.19 No.6 or larger; 40 mm 1-1/2 IN for reinforcing bars less than No.19 No.6.
 - 3. Interior surfaces: 40 mm 1-1/2 IN for beams, girders, and columns; 20 mm 3/4 IN for slabs, walls and joists with No.36 No.11 bars or smaller, and 40 mm 1-1/2 IN with No.43 No.14 and No.57 No.18 bars.
- B. Place bars to following tolerances:
 - 1. Clear distance to formed surfaces: Plus or minus 6 mm 1/4 IN.
 - 2. Minimum spacing between bars: Minus 6 mm 1/4 IN.
 - 3. Top bars in slabs and beams:
 - a. Members 205 mm 8 IN deep or less: Plus or minus 6 mm 1/4 IN.
 - b. Members between 205 and 610 mm 8 and 24 IN deep: Plus/minus 13 mm 1/2 IN.
 - c. Members more than 610 mm 2 FT deep: Plus or minus 25 mm 1 IN.
 - 4. Crosswise of members: Spaced evenly within 50 mm 2 IN.
 - 5. Lengthwise of members: Plus or minus 50 mm 2 IN.
- C. Bars may be moved as necessary to avoid interference with other reinforcing steel, conduits, or embedded items. If moved more than one bar diameter, or enough to exceed above tolerances, resulting arrangement of bars subject to approval.
- D. Assure that reinforcement, at time concrete is placed, is free of materials that may adversely affect or reduce bond. Reinforcement with rust, mill scale or a combination of both will be accepted as being satisfactory without cleaning or brushing provided dimensions and weights, including heights of deformations, of a cleaned sample is not less than required by applicable ASTM.
- E. Support reinforcement and fasten together to prevent displacement by construction loads or placing of concrete beyond tolerances indicated. On ground, provide supporting concrete blocks or other approved method. Over formwork, use concrete, metal, plastic or other approved bar chairs and spacers. Where concrete surface will be exposed to weather in finished structure, furnish accessories within 13 mm 1/2 IN of concrete surface of non-corrosive material or protect against corrosion.

-
- F. Overlap welded wire reinforcement wherever successive mats or rolls are continuous, in such a way that overlap measured between outermost cross wires of each fabric sheet is not less than spacing of cross wires plus 50 mm 2 IN. Unless shown otherwise on the drawings, support as required for reinforcing bars by methods of Paragraph E above.
 - G. As indicated on drawings, offset vertical bars in columns at least one bar diameter at lapped splices. To ensure proper placement, furnish templates for column vertical bars and dowels.
 - H. Splices not specifically indicated shall be subject to approval.
 - I. Unless permitted by Architect/Engineer, do not bend reinforcement after embedding in hardened concrete.
 - J. Unless permitted by Architect/Engineer, do not tack weld reinforcing.

END OF SECTION

SECTION 03 20 10**CONCRETE REINFORCING****PART I - GENERAL****1.1 SUMMARY**

- A. Description: This Section covers the work of furnishing and placing concrete reinforcement, either plain, epoxy coated, or hot dip galvanized, as shown on the Contract Drawings. The work includes material, equipment, and labor necessary to procure, fabricate, install, and erect in field the concrete reinforcement.

1.2 REFERENCES

<u>Sponsor</u>	<u>Number</u>	<u>Subject</u>
ACI	318	Building Code Requirements for Structural Concrete
ACI	315	Details and Detailing of Concrete Reinforcement
ASTM	A 82	Plain Steel Wire for Concrete Reinforcement
ASTM	A 153	Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Hardware
ASTM	A 185	Welded Plain Steel Wire Fabric for Concrete Reinforcement
ASTM	A 496	Deformed Steel Wire for Concrete Reinforcement
ASTM	A 497	Welded Deformed Steel Wire Fabric for Concrete Reinforcement
ASTM	A 615	Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
ASTM	A 706	Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM	A 767	Zinc-coated (Galvanized) Steel Bars for Concrete Reinforcement
ASTM	D 3963	Epoxy Coated Reinforcing Steel Bars
ANSI/AWS	D 1.4	Structural Welding Code - Reinforcing Steel
CRSI		Manual of Standard Practice
AASHTO	M 55	Steel Welded Wire Fabric, Plain, for Concrete Reinforcement

1.3 SUBMITTALS

- A. Submittals shall be made in accordance with the requirements of the Project Quality Plan, except as modified herein.
- B. Prior to fabrication and before ordering material, submit all order lists and bending diagrams (shop drawings) in compliance with the Contract Drawings to the Engineer for review and approval.

- C. Certified copies of mill test reports shall be submitted for each heat or shipment. The reports shall cover the chemical and mechanical properties of the reinforcing steel as specified in ASTM A 615 or ASTM A 706, as applicable.
- D. Welder qualifications and welding procedure shall be submitted at least 30 days before any welding is to be performed.

1.4 QUALITY CONTROL

- A. Quality control shall be made in accordance with the requirements of the Project Quality Plan, except as modified herein.
- B. Epoxy coating and patching/repair material shall be prequalified according to ASTM D 3963. All testing shall be performed by third party testing laboratory approved by the Engineer. The Engineer will review all test data to determine whether the material meets the prequalification requirements.
- C. Submit together with every epoxy coated reinforcing bar shipment a written statement certifying the coated bars were cleaned, coated, and tested according to ASTM D 3963 and as modified by this Section and that the prequalified coating material is used.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Do not damage the bars during handling and storage.
 - 1. Lift all bundles with strong-back, multiple supports, or a platform bridge.
 - 2. Do not drop or drag bars.
 - 3. Use systems with padded contact areas when handling epoxy coated bars.
 - 4. Pad all bundling bands for epoxy coated bars.

PART II – PRODUCTS

2.1 MATERIALS

- A. Reinforcing steel shall conform to the following requirements:
 - 1. Deformed bars, ASTM A 615, Grade 60.
 - 2. Deformed bars, ASTM A 706, Grade 60.
 - a) These deformed bars are weld-able and shall be used for vertical and horizontal reinforcement in the bridge columns and column structural hinges, including their extensions into the pile cap and bent cap unless noted otherwise on the Contract Drawings.
 - 3. Welded wire fabric, ASTM A 185.
 - 4. Dowels, ASTM A 663, Grade 60. Coat with grease or other approved material for bond prevention where specified.
 - 5. Spiral reinforcement, ASTM A 82, except that f_y shall be the stress corresponding to a strain of 0.35 percent if design yield exceeds 60,000 psi.

- B. Bar Supports
- Bar supports in contact with exposed surfaces and for coated reinforcement shall be plastic or plastic coated. Other supports shall be plastic or concrete stone. Broken stone, metal pipe, brick chips, or wood are prohibited.
- C. Tie wire shall be 16 gage mild steel. Where epoxy coated reinforcing is used a non-metallic coated tie wire specifically produced for use in tying epoxy coated reinforcement shall be used.
- D. Submit manufacturers' printed materials and one set of sample for review and approval by the Engineer for threaded rebar couplers and mechanical couplers, prior to order and procurement. Submit at least not less than three manufacturers who have supplied the same to similar projects of the same magnitude in the last 3 years.
- E. All concrete reinforcing used in concrete structures detailed and shown on the Contract Drawings shall not be epoxy coated, unless noted otherwise.
- F. All smooth round dowels shall not be epoxy coated, unless noted otherwise on the Contract Drawings.

2.2 EPOXY COATING

- A. Epoxy coating applicator shall be CRSI fusion bonded epoxy coating applicator plant certified. The certification is not required for cold-drawn steel wire and welded steel wire reinforcement.
- B. The Engineer may choose to witness coating processes for project work and obtain specimens for testing.
- C. The coating thickness shall be 200 microns to 300 microns. Apply coating after bar bending, unless the fabricator can demonstrate that satisfactory results can be obtained by coating before bending.
- D. Bent bars with visible cracks or damage in the coating shall be rejected outright.

2.3 ZINC GALVANIZATION

- A. Hot dip galvanization shall be Class 1 and shall be applied after bar fabrication. The average coating thickness shall be 150 microns of a minimum of 3 tests. Bending of galvanized rebars is prohibited.
- B. Remove all grease, dirt, mortar, mill scale, injurious rust, or any other foreign substance from the rebars prior to galvanizing. Injurious rust is the rust not firmly bonded to the steel. Rust that is difficult to remove, even by vigorous scrubbing with a wire brush, shall be considered firmly bonded to the steel.
- C. Galvanized materials shall be free from wet storage stains (white rust). These corrosion deposits, if present, shall be removed in a manner satisfactory to the Engineer prior to incorporation of the members in the work. After removal of these deposits, the coating shall have a uniform appearance free from uncoated spots, lumps, blister, gritty areas, acid flux, and black spots.
- D. Materials with the said defects, or not meeting the finish and adherence of coating requirements as defined in ASTM A 767 will be rejected and immediately removed from the work site.

2.4 WIRE AND WIRE REINFORCEMENT

- A. Cold-Drawn Steel Wire: As specified. Meet AASHTO M 55.
- B. Welded Steel Wire Reinforcement: As specified. Meet AASHTO M 55.
- C. Tie Wire: 16 gauge before coating.
 - 1. Use coated wire.

2.5 MECHANICAL ANCHORAGE DEVICE

- A. Splice Coupler (Same coating system as bar)
 - 1. Reinforcing steel splice coupler shown by tests to be capable of developing in tension 175 percent of the strength of the reinforcing bar without damage to the concrete.
 - 2. Steel Plate: Meet ASTM A 36.

2.6 QUALIFICATION OF WELDING AND MECHANICAL SPLICING

- A. Procedures to be used in making splices in reinforcing bars and welders and operators employed to make splices in reinforcing bars shall be qualified by tests performed by the Contractor on sample splices of the type to be used, before making splices to be used in the work.
- B. Welders and weld procedures shall be qualified in conformance with the requirements in AWS D1.4.
- C. Each operator qualification test for mechanical splices shall consist of 2 sample splices. Each mechanical splice procedure test shall consist of 2 sample splices.
- D. Sample splices shall be made on the largest reinforcing bar size to be spliced by the procedure or operator being tested.
- E. When joining new reinforcing bars to existing reinforcement, the qualification test sample bars shall be made using only the deformation patterns of the new reinforcement to be joined.
- F. Each operator qualified for mechanical splicing of reinforcing bars of a given size shall be considered also qualified for all reinforcing bar sizes smaller than those used in making the tests.
- G. The Contractor, at the Contractor's option, may have operator and procedure qualification tests performed simultaneously.
- H. Mechanical splice procedures and operators may be approved by the Engineer, based upon approval of previous tests performed on appropriate sample splices.
- I. Completed sample splices shall be at least 3 feet long with the splice at mid-length.
- J. The sample splices shall be made and tested by the Contractor in the presence of the Engineer. When samples are tested by a commercial agency, the test shall be witnessed by the Engineer.

2.7 JOB CONTROL TEST

- A. When mechanical butt splices, shop produced complete joint penetration butt welded splices or shop produced resistance butt welded splices are used, the Contractor shall furnish job control tests from a qualified testing laboratory. A job control test shall consist of the fabrication, under conditions used to produce the splice, and the physical testing of 3 sample splices for each lot of 150 splices.
- B. A lot of mechanical butt splices is defined as 150, or fraction thereof, of the same type of mechanical butt splices used for each combination of bar size and bar deformation pattern that is used in the work.
- D. A lot of shop produced complete joint penetration butt welded splices, or shop produced resistance butt welded splices, is defined as 150, or fraction thereof, of the same type of welds used for each combination of bar size and bar deformation pattern that is used in the work.
- E. When joining new reinforcing bars to existing reinforcement, the job control test shall be made using only the deformation patterns of the new reinforcement to be joined.
- F. Sample splices shall be made and tested in the presence of the Engineer or the Engineer's authorized representative.
- G. Sample splices shall be suitably identified with weatherproof markings prior to shipment to the testing laboratory.
- H. For shop produced complete joint penetration butt welds, shop produced resistance butt welded splices and all types of mechanical butt splices, the Engineer will designate when samples for job control tests are to be fabricated, and will determine the limits of the lot represented by each job control test.
- I. Should the average of the results of tests made on the 3 sample splices or should more than one sample splice in any job control test fail to meet the requirements for splices, all splices represented by that test will be rejected by the Engineer unless the Contractor, obtains and submits evidence, of a type acceptable to the Engineer, that the strength and quality of the splices in the work are acceptable.

PART III - EXECUTION

3.1 PREPARATION

- A. Before concrete is placed, the reinforcement to be embedded shall be free of mortar, oil, dirt, excessive mill scale and scabby rust and other coatings of any character that would destroy or reduce the bond.
- B. Coated reinforcement shall be protected from nicks, gouges or any deformation of the coating. Coated bars shall be inspected before placement for damage to coating. Patch all visual defects in the coating with a pre-qualified patching/repair material conforming to the requirements of AASHTO M 284 before installation. They shall be promptly treated according to the resin manufacturer's recommendations and before detrimental oxidation occurs. Where oxidation is present, it shall be removed by blast cleaning or power tool cleaning methods immediately before the patching material is applied. The patching material shall be feathered 2 to 3 inches or as recommended by the manufacturer into the undamaged coated areas. The patching material thickness shall be greater than 8 mils. Visual damage found after placement shall be cleaned as specified above.

3.2 INSTALLATION

- A. Reinforcing bars shall be accurately placed and securely held in designated position during the placing and compacting of concrete.
- B. Bars may be moved as necessary to avoid interference with other reinforcing steel, conduits, or embedded items. If bars are moved more than one bar diameter, resulting arrangement of bars is subject to approval of the Engineer.
- C. Use precast concrete bar supports only when the concrete is placed in contact with the soil such as foundation mats, base slabs.
- D. Wire bars together with ties at all intersections where spacing is not less than 9 inches; wire bars together with ties at alternate intersections otherwise. Using tie wire with ends pointed away from forms at all intersections and splices. Tolerances, spacing, splices, and concrete protection shall conform to Chapters 7 and 12 of ACI 318.
- E. Bar laps shall be in contact and securely tied. Length of laps for bars shall conform to requirements of ACI 318, except as otherwise indicated.
- F. Welded wire fabric shall be lap spliced at least one full meshes and staggered to avoid continuous laps in either direction and wired securely.
- G. Reinforcement shall be continuous through construction joints except as otherwise indicated on the Contract Drawings.
- H. Reinforcement or other fixed metal items shall not be continuous through expansion joints. Reinforcement shall have a clearance of 2 inches from each face of expansion joint.
- I. Bars shall not be field bent unless otherwise approved by the Engineer. Bars shall not be bent or straightened in a manner that will damage the bars. The use of heat to bend or straighten bars is prohibited.
- I. Welding of reinforcing steel will be allowed only where indicated and when approved in writing by the Engineer. Welding reinforcing steel shall be performed in accordance with AWS D1.4, and only by operators qualified in accordance with AWS D1.4. Welding shall be performed by qualified welders only. Do not tack-weld reinforcing bars in place.
- K. All reinforcing steel in walls, beams, columns, and slabs of culverts, tanks or other structures containing or transferring water, waste water, or sewage, shall be supported on, or held away from forms, by using precast concrete blocks, so no metal is exposed on the face of the concrete when the forms are stripped.
- L. Any epoxy-coated reinforcement that is field cut shall be coated with epoxy paint as approved by the Engineer.

3.3 FIELD CUTTING

- A. Saw or shear coated bars that are specified to be cut in the field. Do not flame cut.
- B. Repair the sawed or sheared end using the specified patching or repair material.

3.4 SPLICING

-
- A. Furnish all reinforcing steel in the lengths specified.
 - B. Do not splice bars, except where specified.
 - C. Stagger splices as far as possible.
 - D. Place and tie lapped splices in the bars. Maintain the minimum distance to the surface of the concrete shown.
 - E. Do not lap splice No. 14 and No. 18 bars.
 - 1. Use mechanical butt splices when using No. 14 or No. 18 bars.
 - a. Decide the number and location of the splices with the following limitations:
 - 1) Extend bars a minimum of 10 ft above the top of footing.
 - 2) Stagger splices such that no particular bar designation is spliced more than 50 percent in 5 ft.
 - b. Use a standard, approved, exothermic process for mechanical butt splicing where the molten filler metal, contained by a high-strength steel sleeve of larger inside diameter than the bars, is introduced into the annular space between bars and the sleeve and between the ends of the bars.
 - c. After cooling and hardening of the filler metal, the splice must be capable of transferring the minimum ultimate tensile strength of the reinforcing bar from one bar to the other by the mechanical strength of the splice components.
 - d. The splice must not depend on fusion of the filler metal with the bars.
 - 1) Do not heat the bars to their melting point during the splicing process.
 - 2) Do not allow the degree of heat required to affect the splice to decrease the structural properties of the bars or affect their original hardness.
 - e. Splice according to the manufacturer's recommendations using the manufacturer's standard jigs, clamps, ignition devices, and other required accessories to make splices. Preheat bars where required by the manufacturer.
 - F. Use one of the following mechanical butt splices for bars sizes No. 3 through No. 11 when designated on the plans. Follow the manufacturer's published recommendations for equipment and splicing procedures.
 - 1. A full mechanical connection that develops in tension or compression at least 175 percent of the specified yield strength of the bar.
 - 2. As described in this Section, article 3.4, Splicing, paragraph E.
 - G. Individual hoops made continuous with butt welded splices may be substituted for bar

spiral reinforcement.

1. Butt welded splices in reinforcing bars shall be complete joint penetration butt welds conforming to the requirements in AWS D1.4
2. At the option of the Contractor, shop produced resistance butt welds that are produced by a fabricator who is approved by the Engineer, may be used. These welds shall conform to the requirements of these specifications.
3. Only the joint details and dimensions as shown in Figure 3.2, "Direct Butt Joints," of AWS D 1.4, shall be used for making complete joint penetration butt welds of bar reinforcement. Split pipe backing shall not be used.
4. Material used as backing for complete joint penetration butt welds of bar reinforcement shall be a flat plate conforming to the requirements in ASTM Designation: A 709, Grade 36. The flat plate shall be $\frac{1}{4}$ mm thick with a width, as measured perpendicular to the axis of the bar, equal to the nominal diameter of the bar, and a length which does not exceed twice the nominal diameter of the bar. The flat plate backing shall be fitted tightly to the bar with the root of the weld centered on the plate. Any bar deformation or obstruction preventing a tight fit shall be ground smooth and flush with the adjacent surface. Tack welds used to fit backing plates shall be within the weld root area so that they are completely consumed by the finished weld. Backing plates shall not be removed.
5. Butt welds shall be made with multiple weld passes using a stringer bead without an appreciable weaving motion. The maximum stringer bead width shall be 2.5 times the diameter of the electrode and slagging shall be performed between each weld pass. Weld reinforcement shall not exceed $\frac{5}{32}$ inch in convexity.
6. Before any electrodes or flux-electrode combinations are used, the Contractor, shall furnish certified copies of test reports for all the pertinent tests specified in AWS A5.1, AWS A5.5, AWS A5.18 or AWS A5.20, whichever is applicable, made on electrodes or flux-electrode combinations of the same class, brand and nearest specified size as the electrodes to be used. The tests may have been made for process qualification or quality control, and shall have been made within one year prior to manufacture of the electrodes and fluxes to be used. The report shall include the manufacturer's certification that the process and material requirements were the same for manufacturing the tested electrodes and the electrodes to be used.
7. Electrodes for manual shielded metal arc welding of ASTM Designation: A 615, Grade 60 bars shall conform to the requirements in AWS A5.5 for E9018-M or E10018-M electrodes.
8. Electrodes for manual shielded metal arc welding of ASTM Designation: A 706 bars shall conform to the requirements in AWS A5.5 for E8016-C3 or E8018-C3 electrodes.
9. Solid and composite electrodes for semiautomatic gas metal-arc and flux-cored arc welding of Grade 300 reinforcing bars shall conform to the requirements in AWS A5.18 for ER70S-2, ER70S-3, ER70S-6 or ER70S-7 electrodes; or AWS A5.20 for E70T-1, E70T-5, E70T-6 or E70T-8 electrodes.
10. Electrodes for semiautomatic welding of ASTM Designation: A 615, Grade 60 and ASTM Designation: A 706 bars shall produce a weld metal deposit with properties conforming to the requirements of Section 5.3.4 in AWS D1.1 for

ER80S-Ni1, ER80S-Ni2, ER80S-Ni3, ER80S-D2, E90T1-K2 and E91T1-K2 electrodes.

11. Reinforcing bars shall be preheated for a distance of not less than 6 inches on each side of the joint prior to welding.
12. For all welding of ASTM Designation: A 615, Grade 40 or Grade 60 bars, the requirements of Table 5.2, "Minimum Preheat and Interpass Temperatures," of AWS D1.4 are superseded by the following:
 - a. The minimum preheat and interpass temperatures shall be 390°F for Grade 40 bars and 570°F for Grade 60 bars. Immediately after completing the welding, at least 6 inches of the bar on each side of the splice shall be covered by an insulated wrapping to control the rate of cooling. The insulated wrapping shall remain in place until the bar has cooled below 190°F.
13. When welding different grades of reinforcing bars, the electrode shall conform to Grade 40 bar requirements and the preheat shall conform to the Grade 60 bar requirements.
14. In the event that any of the specified preheat, interpass and post weld cooling temperatures are not met, all weld and heat affected zone metal shall be removed and the splice rewelded.
15. Welding shall be protected from air currents, drafts and precipitation to prevent loss of heat or loss of arc shielding. The method of protecting the welding area from loss of heat or loss of arc shielding shall be subject to approval by the Engineer.
16. Reinforcing bars shall not be direct butt spliced by thermite welding.

PART IV - MEASUREMENT

- 4.1 Measurement** – No Separate measurement will be made for Work described in this Section.

PART V - PAYMENT

- 5.1 Payment** – Payment for items in this Section will be incidental to the Contract unit cost of the concrete bid items.

END OF SECTION

SECTION 03 25 10**CONCRETE JOINT CONTROL****PART I - GENERAL****1.1 SUMMARY**

A. Description

1. Joint Filler, Joint Sealer, and Waterstops.

1.2 REFERENCED STANDARDS

<u>Sponsor</u>	<u>Number</u>	<u>Subject</u>
AASHTO	M 148	Liquid Membrane-Forming Compounds for Curing Concrete
AASHTO	M 153	Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction
AASHTO	M 213	Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
AASHTO	T 132	Tensile Strength of Hydraulic Cement Mortars
AASHTO		Standard Specifications for Highway Bridges
ASTM	C 509	Elastomeric Cellular Preformed Gasket and Sealing Material
ASTM	C 719	Adhesion and Cohesion of Elastomeric Joint Sealants Under Cyclic Movement (Hockman Cycle)
ASTM	D 412	Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers-Tension
ASTM	D 794	Determining Permanent Effect of Heat on Plastics
ASTM	D 1084	Viscosity of Adhesives
ASTM	D 1621	Compressive Properties of Rigid Cellular Plastics
ASTM	D 1622	Apparent Density of Rigid Cellular Plastics
ASTM	D 1623	Tensile and Tensile Adhesion Properties of Rigid Cellular Plastics
ASTM	D 2240	Rubber Property-Durometer Hardness
ASTM	D 2628	Preformed Polychloroprene Elastomeric Joint Seals for Concrete Pavements

ASTM	D5329	Standard Test Methods for Sealants and Fillers, Hot Applied for Joints and Cracks in Asphaltic and Portland Cement Concrete Pavements
ASTM	D 6690	Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements
FED	TT-S-00230	Sealing Compound: Elastomeric Type, Single Component
MIL	S-8802	Sealing Compound Temperature-Resistant, Integral Fuel Tanks and Fuel Cell Cavities, High Adhesion

1.3 SUBMITTALS AND INFORMATION TO BE RETAINED

- A. For Silicone Joint Sealer: Retain manufacturer's certified test results of each lot of the joint sealant material, except for the bond to cement mortar test. Certificate must show use of primers, where applicable.
- B. Retain Certificate of Compliance when the sealant is delivered to the job site. Certificate must include:
 - 1. Verification of test results
 - 2. Manufacturer's name
 - 3. Lot number
 - 4. Expiration date of the shelf-life warranty
 - 5. Sealer trade name
 - 6. Project destination
 - 7. Representative sealant

1.4 QUALITY ASSURANCE/QUALITY CONTROL

Quality assurance/quality control shall be in accordance with the requirements of the Project Quality Plan, except as modified herein.

PART II - PRODUCTS

2.1 PREFORMED ELASTOMERIC JOINT SEALANTS

- A. Preformed elastomeric joint seal material made of vulcanized elastomeric compound using polymerized chloroprene as the only basic elastomer.
- B. The Engineer will provide a statement of no objection for the shape of any joint sealer prior to submission of the individual production lot.
- C. The Engineer evaluation requirements for any joint seal geometry are:
 - 1. Overall width of sealer: $\frac{7}{16}$ " minimum.
 - 2. Overall depth of sealer: maximum of 1" when compressed to $\frac{7}{32}$ ".
 - 3. Materials Physical Property: Conform to ASTM D 2628.
 - 4. Maintain the force-deflection requirements in Table 1.

Table 1

Deflection Condition	Force Requirement
Seal compressed to $\frac{3}{8}$ " width	1 lb/in minimum
Seal compressed to $\frac{7}{32}$ " width	12 lb/in maximum

5. Heat-age the specimens used for determining the original force-deflection relationship in an oven for 70 hours at 212 degrees F under 50 percent deflection.
6. Subject the specimens to another force-deflection test after heat-aging and comply with the requirements in Table 2.

Table 2

Deflection Condition	Force Requirement
Seal compressed to $\frac{3}{8}$ " width	1 lb/in minimum
Seal compressed to $\frac{7}{32}$ " width	12 lb/in maximum

- D. Use a one-component, polychloroprene, lubricant adhesive containing only soluble phenolic resins blended with anti-oxidants and acid acceptors in an aromatic hydrocarbon solvent mixture with the following properties:
1. Average net weight 7.8 lb/gal.
 2. Solids content by weight of 22-28 percent. Meet ASTM D 1084.
 3. Suitable viscosity for use with installation equipment.
 4. Film strength of 2300 psi minimum tensile strength and 750 minimum percent elongation before breaking. Meet ASTM D 412.
 5. Manufactured within 9 months of use.
 6. Deliver in containers plainly marked with the manufacturer's name or trade mark, lot number, date of manufacture. Send manufacturer's certification of specification compliance.
- E. The Engineer may sample and test materials after delivery to the project site.

2.2 HOT-POURED JOINT SEALANT

- A. As specified for general requirements, physical properties, packing, marking, and sampling. Meet ASTM D 6690 Type II.
- B. Test physical requirements as specified in ASTM D 5329.

2.3 PREMOLDED JOINT FILLERS

- A. As specified.
- B. Meet AASHTO M 153 and AASHTO M 213.

2.4 SILICONE JOINT SEALER

- A. Select and use a prequalified sealant from the Qualified Products Listing, available from UDOT.

- B. Silicone joint sealer and special category for self-leveling: both made of low-modulus silicone specifically formulated to seal Portland Cement Concrete Pavement joints.
- C. Furnish in a one-part, non-acid curing formulation.
- D. Meet the following physical requirements:
1. Refer to the plan details.
 2. Backer rod compatible with the sealant and all components of the joint sealant system. Meet the requirements for Backer Rod.
 3. Prevent any bond or adverse reaction from occurring between the backup materials and the sealant.
- E. Meet the test requirements in Tables 3 and 4.

Table 3

Test Requirements (Silicone Joint Sealer) and Test Methods		
Tensile Stress; 150 percent max elongation, 7 day cure at 77 ± 3 degrees F. And 45-55 percent relative humidity (rh).	45 psi	ASTM D 412 (DIE C)
Flow	0.3 inch maximum	MIL S 8802
Extrusion Rate 100 degrees to 0 degrees F.	0.2 - 0.6 lbs/min	MIL S 8802
Tack-Free Time		
Specific Gravity	1.01 - 1.515	MIL S 8802
Durometer Hardness, shore A: cured 7 days at 77 ±3 degrees F and 45-55 percent relative humidity (rh).	10-25 (0 degrees F)	ASTM D 794 Method A
Shelf life	6 month minimum from date of shipment from plant or point of manufacture.	ASTM D 2240
Ozone and Ultraviolet (UV) Resistance	No chalking, cracking, or bond loss after 5000 hours	
Bond to concrete mortar concrete briquette air cured 14 days 77 ±3 degrees F.	50 psi minimum	
Movement capability and adhesion. Magnitude of cycles movement shall be appropriate for sealant category, cure 7 days in air 77 ±3 degrees F then 7 days in water 77 ±3 degrees F.	+100 percent and -50 percent of joint width. No more than 0.5 square inches (adhesive or cohesive) failure in the 3 specimens combined after 10	

	cycles.	
--	---------	--

Table 4

Test Requirements for Self-Leveling (Silicone Joint Sealer) and Test Methods		
Flow, sag, or slump	Self-leveling	
Extrusion Rate	6-12 lbs/min.	MIL S 8802
Elongation, percent minimum	800 at 21 days	ASTM D 412 DIE C, Mod.
Modulus at 150 percent elongation	30 psi maximum after 21 days	
Tensile Adhesion +0 Concrete (minimum percent elongation)	+600 after 21 days	ASTM D 3569
Accelerated Weathering	No chalking, cracking, or bond loss after 5000 hours	
Shelf Life	Six month min. from date of shipment from plant or point of manufacture.	
Durometer Hardness, Shore OO: cured 14 days at 77 ±3 degrees F and 45-55 percent, rh	20-80 (0 degrees F)	ASTM D 2240
Movement capability and adhesion. Magnitude of cycles movement shall be appropriate for sealant category, cure 14 days in air 77 ±3 degrees F, and then 7 days in water 77 ±3 degrees F	+100 percent and -50 percent of joint width. No more than 0.5 square inches (adhesive or cohesive) failure in the three specimens combined after 10 cycles.	

- F. Department determines the bond to concrete mortar with the following test:
1. Test as specified in AASHTO T 132.
 2. Briquettes molded as specified, sawed in half, and bonded with a thin section of sealant.
 3. Briquettes dried to a constant weight in oven at 100 ± 5 degrees F.
- G. Department uses the following test following ASTM C 719 for movement capability and adhesion:
1. Prepare 1 inch by 1 inch by 3 inch concrete blocks as specified.
 2. Use a sawed face for the bond surface.

3. Seal 2 inches of block, leaving $\frac{1}{2}$ inch on each end of specimen unsealed.
 4. Dimension the sealant to a $\frac{3}{8}$ inch depth and a $\frac{1}{2}$ inch width.
 5. Subject sealant to movement as specified.
 6. Magnitude of the movement must meet each specific category, and the rate of extension or compression must be $\frac{1}{8}$ inch per hour.
- H. Take one or more random samples (minimum of 2 quarts per sample) of each lot and seal in airtight containers.
1. Notify Engineer when stockpiles located at either the job site or the vendor's place of business are ready to be sampled.
 - a. Establish job site stockpiles at least 30 working days prior to use.
 - b. Establish vendor's place of business stockpiles 40 working days prior to use.
 2. The Department may take samples at the sealant manufacturing plant at least 30 days before shipment to the job site.
 3. Laboratory testing may take 30 working days after submitting samples.
- I. Do not place any materials until testing is completed and materials are approved by the Engineer.
- J. Sealant must be delivered in the manufacturer's original sealed container, displaying the lot number, expiration date of the shelf-life warranty, and the sealer trade name.
- K. Submit Certificate of Compliance to the Engineer when the sealant is delivered to the job site. Certificate must include:
1. Verification of test results
 2. Manufacturer's name
 3. Lot number
 4. Expiration date of the shelf-life warranty
 5. Sealer trade name
 6. Project destination
 7. Representative sealant

2.5 BACKER ROD

- A. Use closed-cell, polyethylene-foam rods conforming to the requirements in Table 5.

Table 5

Backer Rod Requirements and Test Methods		
Diameter	Joint width + $\frac{1}{8}$ "	
Density	2 lb/ft ³	ASTM D 1622
Tensile Strength	25 psi	ASTM D 1623
Absorption	0.5 percent by volume	ASTM C 509
Compression Reflection	25 percent at 8 psi	ASTM D 1621

2.6 JOINT SEALER (STRUCTURES)

- A. Cold-applied, gun-grade, single-component, polyurethane base material that cures under field condition to form a rubber-like, non-sag, elastomeric joint seal, as specified in FS TT-S-00230 C Type II, Class A.
- B. Use material that bonds tightly to the sides of the concrete groove and exhibits the physical properties in Table 6 when cured and tested after 21 days at 73 °F.

Table 6

Physical Properties of Joint Sealer (Structures) and Test Methods		
Modulus of Elasticity at 100% Elongation	132 psi	ASTM D 412
Hardness (Shore A)	40 ± 5	
Elongation (at break)	700 %	ASTM D 412
Recovery	Greater than 90%	
Tensile Strength	190 psi	ASTM D 412
Adhesive in Peel	20 lb/in	TT-S00230 C Type II, Class A
Service Range	-40 °F to 150 °F.	TT-S-00230 C
Initial Cure, Tack Free (Depending on Temperature and Humidity)	6 to 8 hours	
Final Cure	5 to 8 days	
Staining Characteristics	Nonstaining	
Color	Gray	

2.7 WATERSTOPS

- A. Provide waterstops as specified.
- B. Meet AASHTO Standard Specifications for Highway Bridges, Division II, Subsection 8.9.2.6.

PART III – EXECUTION

NOT USED

PART IV - MEASUREMENT

4.1 Measurement – No Separate measurement will be made for Work described in this Section.

PART V - PAYMENT

5.1 Payment – Payment for items in this Section will be incidental to the Contract unit cost of the concrete bid items.

END OF SECTION

SECTION 03 30 00**CAST-IN-PLACE CONCRETE****PART I - GENERAL****1.1 SUMMARY**

- A. Description: This work includes furnishing and placing cast-in-place concrete as shown on the Contract Drawings and as specified herein. This work shall be constructed in accordance with these specifications and in conformity with the lines, grades, dimensions and notes shown on the Contract Drawings.

1.2 REFERENCES

<u>Sponsor</u>	<u>Subject</u>
ACI 211.1	Selecting Proportions for Normal, Heavyweight, and Mass Concrete
ACI 301	Structural Concrete for Buildings
ACI 305	Hot Weather Concreting
ACI 306	Cold Weather Concreting
ACI 318	Building Code Requirements for Reinforced Concrete
AASHTO M 45	Aggregate for Masonry Mortar
AASHTO M 295	Fly Ash and Raw or Calcinated Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete
AASHTO T 26	Quality of Water to be Used in Concrete
AASHTO T 23	Making and Curing Concrete Test Specimens in the Field
AASHTO T 126	Specimens in the Laboratory
ASTM C 33	Concrete Aggregates
ASTM C 39	Compressive Strength of Cylindrical Concrete Specimens
ASTM C 94	Ready-Mixed Concrete
ASTM C 150	Portland Cement
ASTM C 171	Sheet Materials for Curing Concrete
ASTM C 192	Making and Curing Concrete Test
ASTM C 260	Air-Entraining Admixtures for Concrete
ASTM C 309	Liquid Membrane-Forming Compounds for Curing Concrete

ASTM C 387	Packaged, Dry, Combined Materials for Mortar and Concrete
ASTM C 494	Chemical Admixtures for Concrete
ASTM C 566	Total Moisture Content of Aggregate by Drying
ASTM C 1017	Chemical Admixtures for Use in Producing Flowing Concrete
ASTM D 1190	Concrete Joint Sealer, Hot-Poured Elastic Type
ASTM D 1751	Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types)
ASTM D 1752	Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction
MoDOT	2011 Missouri Standard Specification Book for Highway Construction

1.3 SUBMITTALS

- A. At least 30 days prior to the start of placing concrete, design mixes shall be submitted to the Engineer for review and approval for each class of concrete, indicating that the concrete ingredients and proportions will result in a concrete mix meeting the requirements specified.
1. With each mix design, submitting laboratory test results including compressive strength at 28 days and mill or manufacturer's certificates attesting to conformance of ingredients with Specifications.
 2. Include the source, brand or characteristic properties of the ingredients need to be varied during the term of the Contract, revised laboratory mix reports shall be submitted for review and approval.
- B. Product data for admixtures shall be submitted with the concrete mix design. Curing compounds, curing-sealer, accessories, and other data shall be submitted or as requested by the Engineer.
- C. A construction joint layout for exposed horizontal surfaces shall be submitted to and approved by the Engineer before beginning field layout and prior to placing concrete.
- D. Certificates of compliance with the Specification shall be submitted to the Engineer for all commercial products, including industry standardized products prior to incorporation in the work.
- F. A placing schedule, within the basic project schedule, shall be submitted before starting placing operations, with dates and sequences of each proposed concrete placement.
- E. Batching and mixing plant certifications shall be submitted to the Engineer.
- F. Batch tickets containing the approved mix number and conforming to the requirements of ASTM C 94, Sections 16.1 and 16.2 shall be submitted with each delivery of concrete. Concrete deliveries without the approved mix number on the tickets will be rejected. Amount of water added in the mixing and any additional amount allowed at the job site to meet mix design requirements shall be shown on the batch ticket.

- G. Daily inspection reports for all work each day and final report for each area or structure.

1.4 QUALITY CONTROL

- A. Batching and mixing plants shall certify compliance with the requirements of ASTM C 94 and shall be certified by the National Ready Mix Concrete Association.
- B. The Contractor shall take such periodic control tests of materials and resultant concrete as specified herein and as are necessary to ensure that concrete produced meets specification requirements.
- C. Re-tempering any partially hardened concrete with additional water will not be permitted.
- D. Prior to and during placement of reinforced structural concrete, Inspector shall inspect formwork, reinforcement, conduit embedments, anchor bolts, and other elements of the work in addition to concrete placement.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. The various materials comprising concrete shall be delivered, handled and stored to preserve their quality for the work.
- B. Cement shall be used in the chronological order of receipt.
- C. Batch bins shall be constructed so as to be self-cleaning during drawdown.
- D. Aggregates shall be stored and handled to prevent contamination and commingling of separate gradations.
- E. Control of uniform moisture content in aggregate and accurate measurement shall be maintained.

PART II - PRODUCTS

2.1 MATERIALS

- A. Cement: Cement shall comply with the requirements of Section 03 15 16, Portland Cement Concrete.
- B. Fly ash: Fly ash shall comply with the requirements of Section 03 15 16, Portland Cement Concrete.
- C. Aggregates: Fine and coarse aggregate shall comply with the requirements of Section 03 15 16, Portland Cement Concrete.
- D. Water used in all work must be clean and free of oil, salt, acid, alkali, sugar, vegetable matter, or other substances deleterious to the finished product. Use water conforming to AASHTO T 26 for mixing and curing Portland cement concrete, mortar or grout. Water of approved potable quality may be used without test.
- E. Admixtures: Air-entraining admixture (AEA) and water reducing agents shall comply with the requirements of Section 03 15 16, Portland Cement Concrete.
- F. Expansion Joint Material: Expansion joint material shall conform to Section 03 15 16.13, Expansion Joint.

- G. Concrete Joint Sealer: Joint sealer shall conform to Section 03 15 16.13, Joint Sealers.
- H. Sheet Materials for Curing Concrete: Sheet materials for curing concrete shall conform to the requirements of ASTM C 171.
- I. Curing Compounds: Curing compounds shall conform to the requirements of ASTM C309, Type I-D, Class A.
- J. Waterstops: Waterstops shall conform to Section 1057.7, Joints for Concrete Structures of the 2011 Missouri Standard Specification Book for Highway Construction (MoDOT).
- K. Cement Mortar: Use either standard premixed mortar conforming to ASTM C 387, or mortar proportioned with one part Portland cement to two parts clean, well-graded sand which passes a $\frac{1}{8}$ inch screen and which conforms to AASHTO M 45. Admixtures may be used, but do not exceed the following percentages of cement by weight: hydrated lime, 10%, and diatomaceous earth or other inert materials, 5%.
- L. Cement, fly ash, aggregates, and embedments shall be free of calcium chloride.

2.2 EQUIPMENT

- A. Spare vibrators in working condition shall be maintained at the site of each placement. The number of the spares shall be dependent upon the volume of the concrete to be placed or the area of structure to be cast.
- B. Equipment having components of aluminum or magnesium alloy, which would have contact with plastic concrete during mixing, transporting or pumping of Portland cement concrete, shall not be used.
- C. The Concrete Supplier shall have sufficient plant capacity and transporting and placing equipment to ensure continuous delivery of concrete at the rate required. The rate of delivery of concrete during concreting operations shall be such as to provide for the proper handling, placing, and finishing of the concrete. The method of delivery and handling of the concrete shall be such to minimize re-handling of the concrete and avoid damage to the structure or the concrete.

2.3 CONCRETE COMPRESSIVE STRENGTH

- A. Compressive Strength: The 28-day compressive strengths (f'_c) of concrete used on the project and the location where they are used shall be as indicated below unless noted otherwise on the Contract Drawings.
 - 1. 4000 psi/AA (AE): Use for all bridge decks, approach slabs, pier bents and abutments, substructure components (including footings), MSE wall panels, and pile caps. Use at all locations where other strengths are not indicated.
 - 2. 3000 psi/A (AE): MSE Wall footings and pipe pile concrete infill.
- B. Mix Design: Mix design shall conform to Section 3304, Portland Cement Concrete.

PART III - EXECUTION

3.1 CONSTRUCTION JOINTS

See Section 1057.7, Joints for Concrete Structures of the 2011 Missouri Standard Specification Book for Highway Construction (MoDOT).

3.2 INSTALLATION OF CONCRETE ACCESSORIES

- A. Comply with manufacturer's written instructions and recommendations for the installation of each type of accessory required, unless more stringent requirements are shown on the Contract Drawings or specified in the Specifications.
- B. Expansion joint filler installation shall conform to Section 03 15 16.13 Expansion Joint for Structures. Joint sealant shall conform to Section 03 15 16.13 Joint Sealers.
- C. Non-Shrink Grout and Drypack
 - 1. Prepare concrete surface as recommended by manufacturer.
 - 2. Mix grout as recommended by manufacturer.
 - 3. Place mixture as recommended by manufacturer.
 - 4. Cure as recommended by manufacturer.
 - 5. Match finish color with surrounding concrete.

3.3 PLACING OF CONCRETE

(See Section 03 31 05 Articles 3.4)

3.4 CONSOLIDATION OF CONCRETE

(See Section 03 31 05 Article 3.6)

3.5 FINISHES AND FINISHING

(See Section 03 31 05 Articles 3.7)

3.6 PROTECTING AND CURING

(See Section 03 39 00)

3.7 TOLERANCES

- A. Tolerances on formed and unformed surfaces shall be in accordance with ACI 301, unless otherwise indicated or specified elsewhere in these Specifications.
- B. Where not otherwise shown or specified tolerances on unformed surfaces shall be Class B, slab tolerances at $\frac{1}{4}$ inch in 10 feet, as determined by a straight edge is acceptable for stations but should not be applied to box culverts.
- C. Bridge decks shall be checked by the Contractor with a straight edge. The surfaces shall not vary more than $\frac{3}{8}$ inches from the lower edge of a 10-foot long straight edge placed in any direction.

- D. The tolerance for the dimension shown on the Contract Drawings between track centerline and nearest structural face is minus zero and plus one half inch, and the variation shall not exceed one-quarter inch in 10 feet.

3.8 FIELD QUALITY CONTROL

- A. Independent Testing Laboratory (ITL): The Contractor shall employ a ITL to cure and test compressive strength test cylinders.
- B. Maintain records of all testing and results of all tests including compression tests. A running average of the 28-Day compression test results shall be maintained and at anytime the average for the last 30 test drops below the required average strength.
- C. Testing frequency shall conform to Section 03 15 16 Portland Cement Concrete.
1. Concrete sampling and testing shall be conducted by the Independent Test Lab as defined in the Project Quality Plan.
 2. At a minimum, for each class of concrete placed, take samples for strength tests each day structural concrete is placed.
 3. In addition, take samples for each 100 cubic yards of concrete placed in any one-day and any time there is a discernable change in the concrete being placed.
 4. Perform air, slump and yield tests and the record results each time cylinders are made.
 5. In addition, perform air and slump tests on the initial loads of concrete delivered for placement.
 6. Reject loads with excessive slump.
- D. Evaluation of Test Results:
1. If the test results show that any part of the structure contains material that is not in conformance with the requirements of the Specifications that portion of the work will be subject to rejection by the Engineer.
 2. Any work so rejected by the Engineer shall be removed and replaced as directed by the Engineer.
- E. Load and core tests in accordance with the requirements of ACI 318 shall be made by the Contractor, for the following reasons:
1. Average 28 day strength of any pair of test cylinders more than 10% below design strength.
 2. Average 28 day strength of 3 consecutive pair of test cylinders below design strength.
 3. Evidence of frozen or cold joint concrete.
 4. Evidence of insufficient thickness.

PART IV - MEASUREMENT

4.1 Measurement – No Separate measurement will be made for Work described in this Section.

PART V - PAYMENT

5.1 Payment – Payment for items in this Section will be incidental to the Contract unit cost of the concrete bid items.

END OF SECTION

SECTION 03 31 00
CONCRETE MATERIALS AND PROPORTIONING

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish all labor, materials, tools, equipment, and services for Concrete Materials and Proportioning, as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

- A. ASTM designated specifications for material quality and test methods appear throughout this specification.
 - 1. The serial designation prefixed with ASTM shall identify the specification which shall be a part of this specification.
- B. Standards for concrete work: Comply with applicable provisions of following ACI publications (latest edition) except as otherwise indicated.
 - 1. ACI 301 "Specifications for Structural Concrete for Buildings."
- C. Concrete Mixture Proportioning:
 - 1. Employ and pay for testing agency acceptable to Architect and Owner to perform materials evaluation, testing and design of concrete mixes.
 - 2. Certificates, signed by material producer and Contractor, may be submitted in lieu of material testing when approved by Architect.
- D. Concrete Testing:
 - 1. Specified in Section 03 08 16 (Contractor Pays).
 - 2. Contractor to assist with related communication and temporary storage of test cylinders at jobsite.
- E. Pre-Concrete Conference
 - 1. At least 35 days prior to the start of the concrete construction schedule, the contractor shall conduct a meeting to discuss the approved mix designs and to discuss the required methods and procedures to achieve the required concrete construction. The contractor shall send a pre-concrete conference agenda to all attendees 20 days prior to the scheduled date of the conference.
 - 2. The contractor shall require responsible representatives of every party who is concerned with the concrete work to attend the conference, including but not limited to the following:
 - a. Architect and/or Engineer
 - b. Contractor's superintendent and quality control representative.
 - c. Laboratory responsible for the concrete design mix
 - d. Owners Testing Agency responsible for field quality control
 - e. Concrete subcontractor
 - f. Ready-mix concrete producer
 - g. Admixture manufacturer(s)
 - h. Concrete pumping equipment manufacturer
 - 3. Minutes of the meeting shall be recorded, typed and printed by the contractor and distributed by him to all parties concerned within 5 days of the meeting. One copy of the minutes shall also be transmitted to the Owner's representative for information purposes.

4. The minutes shall include a statement by the concrete contractor indicating that the proposed mix design, and placing, finishing and curing procedures can produce the concrete quality required by these specifications.

1.3 SUBMITTALS

- A. Product Data:
 1. Concrete Mix Designs:
 - a. Each Mix design shall be submitted individually. Do not combine multiple mix designs into a single submittal
 - b. Submit the following data for each concrete mix proposed for use:
 - 1) Intended use of the mix design.
 - 2) Proportions of materials.
 - 3) Slump.
 - 4) Air content.
 - 5) 7-day and 28-day compression test results of trial mixes or those used for standard deviation analysis of an established mix. Test records for use in standard deviation analysis must have been made within 24 months of the date of the submittal and represent a time span of production of not less than 45 days.
 - c. Submit source and certification or proof of quality (and compatibility of admixtures) for each of the constituents of the proposed concrete mixes. Compatibility of admixture must be certified.
 - 1) Cement.
 - 2) Aggregate.
 - 3) Water.
 - 4) Admixtures:
 - a) Air Entraining Admixture.
 - b) High-Range Water Reducer.
 - c) Fly Ash.
 - d) Other.
 - d. Review and approval of mix designs by Architect does not relieve the Contractor of responsibility to provide concrete of the quality and strengths required by the Contract Documents.
 - 1) The Architect's approval is contingent upon satisfactory performance and strengths being achieved in the field.
 - e. Submit Concrete Mix Designs using the mix design submittal form included at the end of this specification:

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Normal Weight Concrete: Concrete for which density is not a controlled attribute.
 1. Materials ultimately used in production must be of same quality, properties and proportion as indicated in approved concrete mix design (as approved by Architect).
- B. Under-slab Vapor Retarder: Specified in Section 03 31 10.
- C. Cement:
 1. Portland cement conforming to ASTM C150 or blended cements conforming to ASTM C595.
 2. Color: Natural gray.
- D. Aggregates:
 1. General:
 - a. Regard fine and coarse aggregates as separate ingredients.

- b. Each size of coarse aggregate, as well as combination of sizes when two or more are used, shall conform to grading requirements of applicable ASTM specifications.
2. Normal Weight Concrete:
- a. ASTM-C33, also aggregate shall be obtained from a source approved by the State Highway Department for use in concrete for state bridges.
- b. Fine aggregate gradation for slab on grade concrete and other designated concrete shall meet the requirements in the following:
- | | | | |
|----|------------|-----------------|-----------|
| c. | Sieve size | Percent passing | |
| d. | | 3/8 | 100 |
| e. | | No.4 | 85 to 100 |
| f. | | No.8 | 80 to 90 |
| g. | | No. 16 | 50 to 75 |
| h. | | No. 30 | 30 to 50 |
| i. | | No.50 | 10 to 20 |
| j. | | No.100 | 2 to 5 |
- E. Potable Water:
1. Conforming to ASTM C1602/C1602M. Potable
- F. Admixtures:
1. General:
- a. Use only when specifically required or permitted by Contract Documents, otherwise must be approved by Architect.
- b. Trial mixes and tests shall be prepared with job materials, including admixture, to demonstrate that there will be no subsequent reduction in strength or durability of hardened concrete.
- c. Conform to appropriate following specifications:
2. Calcium chloride and admixtures containing more than 0.05 percent chloride ions are not permitted.
3. Air-entraining Admixtures: ASTM C260.
4. Mid-Range Water Reducer: ASTM C494, Type A.
5. High-Range Water Reducer :
- a. ASTM C494, Type F or G. Subject to complying with these specifications, the following manufacturers of High Range Water Reducing Admixtures are approved:
- 1) Daracem – 100 or Adva Flow Series by Grace Construction Products.
 - 2) Rheobuild 1000 , Glenium Series or PS 1466 by BASF Construction Chemicals.
 - 3) Eucon 37 or Eucon SPJ by Euclid Chemical.
 - 4) PSP-N, PSP-N2, PSP-R, and PSP-L by Procrete Industries.
- b. Other manufacturers desiring approval comply with Section 00 26 00.
6. Water-reducing, Retarding, and Accelerating Admixtures: ASTM C494.
7. Supplementary Cementitious Materials:
- a. Fly ash - ASTM C618, Class C or Class F.
- 1) Samples shall be obtained, prepared, and tested in accordance with ASTM C311.
- b. Ground Granulated Blast-Furnace Slag: ASTM C989, Grade 100 or 120.
8. Synthetic Macro Fibers
- a. ASTM C1116 Type III
- b. Fiber Reinforced concrete shall provide equivalent reinforcing to WWR indicated in both direct tension and bending capacity for thickness indicated
- c. Testing per ASTM C1018 and/or ASTM C1399 shall indicate a minimum residual flexural strength of 170 PSI. Submit manufacturers data verifying conformance
- d. Minimum Dosage rate 4 lbs/cu.yd.
- e. Acceptable manufacturers

1) W.R.Grace Co,; Strux 90/40

G. Concrete Cleaning Solutions:

1. Specified in Section 03 31 10.
2. Specified in Section 04 05 10.

2.2 PROPORTIONING CONCRETE MIXES

A. General:

1. Contractor and concrete supplier are responsible to provide concrete, in-place, which satisfies all the requirements listed in the following table.
2. Contractor and concrete supplier are also responsible to adjust the concrete mixes, as needed, to:
 - a. Correct for non-conformance.
 - b. Correct for a variation in the quality of a constituent.
 - c. Compensate for extreme conditions in the field.

B. Establish concrete material proportions by any of the proportioning methods described in AC1-301 guidelines.

Concrete Properties Table – IP Units							
Use	28-day strength (KSI)	Dry Unit Weight (PCF)	Max Aggregate Size (IN)	Air %	Max. W/C Ratio	Slump (IN)	Cement type
Footings ,Grade Beams	3.0		1-1/2	4.5	0.60	4	I
Drilled Piers	3.0		1 1/2		0.45	6	I
Walls	4.0		1	4.5	0.50	5	I
Slabs-on-grade	4.0		1 1/2		0.45	3	I
Structural floors, girders, slabs, columns	3.0		3/4		0.45	9	I
Norm. Wt. Slabs on composite metal deck	3.5		3/4		0.50	6	I
All other uses	4.0		3/4	6	0.50	4	I

C. Instructions for use of Table:

1. General:
 - a. Provide concrete mixes with properties indicated in locations identified in “use” column.
2. 28-day Strength:
 - a. Installed concrete must meet or exceed the minimum 28-day compressive strength indicated.
 - b. Laboratory mix design strengths must exceed this strength by the appropriate amount per AC1-301.
 - c. Determine strength in accordance with ASTM C192 and ASTM C39.
3. Dry Unit Weight:
 - a. If no value is listed, assume normal weight.
4. Maximum Aggregate Size:
 - a. Maximum aggregate size is the design aggregate size.
 - b. Maximum size of coarse aggregate determined in accordance with:
 - 1) ASTM C33 for normal weight concrete.

- c. Some mixes are designated "19mm or 25mm, 3/4 IN or 1 IN, permitting contractor option.
 5. Air Content:
 - a. Required percentage of entrained and entrapped air as measured by ASTM C231, ASTM C173, or ASTM C138, as appropriate.
 - b. Tolerance of air content as delivered is \pm 1-1/2 percent for normal weight and \pm 2 percent for lightweight concrete.
 - c. When left blank, required air content is not specified.
 6. Water Reducer:
 - a. Mid Range Water Reducer or High Range Water Reducer shall be provided as necessary to achieve slump indicated.
 - b. Contractor, as option, may elect to use Water Reducers to improve workability or permit pumping.
 7. Maximum W/C Ratio:
 - a. Maximum ratio of kilograms pounds of water allowed to kilograms pounds of cementitious material used in the concrete mix.
 8. Slump:
 - a. Mixes without Water Reducers:
 - 1) Slump tolerance: Up to 25mm 1 IN above maximum indicated is allowed, provided the average of 5 consecutive batches does not exceed the indicated amount by more than a 13mm 1/2 IN.
 - b. Mixes with Water Reducers:
 - 1) Slump indicated is after dosing.
 - 2) Slump tolerance after dosing: +38mm and -25 mm +1-1/2 IN and -1 IN is permitted for each batch.
 - c. Determine slump in accordance with ASTM C143.
 - d. Where slump is not specified, provide concrete with slump in accordance with approved mix designs
 9. Cement:
 - a. Type: Provide cement type indicated.
 - b. As option, the contractor/supplier may use Fly Ash or Ground Blast Furnace Slag for partial replacement of cement.
 - 1) For each unit of cement that is removed, replace with two units of Class F Fly Ash or one unit of Class C Fly Ash maximum 25% replacement.
 - 2) For each unit of cement that is removed, replace with one unit of Ground Blast Furnace Slag
 - 3) Maximum amount of cement replaced shall not exceed that specified in table 4.2.2.7.b.2 of ACI 301
 - 4) W/C ratio shall be based on total cementitious material content
- D. Admixtures:
1. Use admixtures in accordance with manufacturer's instructions.
 2. Use only approved admixtures.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Material Safety Data Sheet and storage labeling shall be available at the job site and conform to current governing regulations.

3.2 STORAGE OF MATERIALS

- A. Store cement in weather tight buildings, bins, or silos which will exclude moisture and contaminants.

- B. Arrange aggregate stockpiles and use in a manner to avoid excessive segregation and to prevent contamination with other materials or with other sizes of like aggregates.
 - 1. To insure that this condition is met, perform test for determining conformance to requirements for cleanliness and grading on samples secured from aggregates at point of batching.
 - 2. Do not use frozen or partially frozen aggregates.
- C. Allow sand to drain until it has reached relatively uniform moisture content before use.
- D. Store admixtures in manner to avoid contamination, evaporation, or damage.
 - 1. For those used in form of suspensions or non-stable solutions, provide agitating equipment to assure uniform distribution of ingredients.
 - 2. Protect liquid admixtures from freezing and temperature changes which would adversely affect their characteristics.

3.3 MIXING AND DELIVERY

- A. Batch, mix and transport concrete in accordance with ASTM C94.
- B. Batch and mix admixtures in accordance with manufacturer's instructions.
- C. Concrete shall have a slump of 50mm to 100mm 2 to 4 IN when it arrives at job site.
 - 1. Water additions at job site shall be limited to comply with W/C Ratio requirements.
 - 2. Do not allow water to be added to the mix unless the amount allowed is clearly indicated on the truck delivery ticket.
- D. Following addition of High Range Water Reducer, mix for a minimum of 70 revolutions or 5 minutes to assure a consistent mixture.
- E. Reduction of required average strength:
 - 1. During construction, and after sufficient data becomes available, laboratory strength of mixes may be reduced in accordance with Section 3.11 of AC1-301, subject to approval by the Architect.

END OF SECTION

SECTION 03 31 05
STRUCTURAL CONCRETE

PART I - GENERAL**1.1 SUMMARY****A. Description**

This work includes concrete placement operations for cast-in-place slabs on grade, slabs on fill, structural building frame, and other concrete components.

1.2 REFERENCES

- A. ACI 301: Specifications for Structural Concrete for Buildings.
- B. ACI 305: Hot Weather Concreting.
- C. ACI 306.1: Cold Weather Concreting.
- D. ACI 309: Standard Practice for Consolidation of Concrete.
- E. ASTM C 881: Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.
- F. ASTM C 1059: Standard Specification for Latex Agents for Bonding Fresh to Hardened Concrete.
- G. ASTM E 1155: Standard Test Method for Determining F_F Floor Flatness and F_L Floor Levelness Numbers.
- H. IBC Section 1905: Concrete Quality, Placing, and Mixing.
- I. AASHTO M 153: Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.
- J. AASHTO M 213: Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Non Extruding and Resilient Bituminous Types).
- K. ASTM C 387: Standard Specification for Packaged, Dry, Combined Materials for Mortar and Concrete.
- L. AASHTO M 45: Aggregate for Masonry Mortar.

1.3 SUBMITTALS

- A. Batch Delivery Ticket: For each batch delivered to site, submit
 - 1. Date.
 - 2. Producer and plant.
 - 3. Job.
 - 4. Name of contractor.

5. Serial number of ticket.
 6. Truck number and time dispatched.
 7. Volume of concrete.
 8. Type of cement.
 9. Amount of cement.
 10. Total water content. (W/C ratio).
 11. Water added for receiver of concrete and receiver's initials.
 12. Admixture types and amounts.
 13. Separate weights of fine and coarse aggregate.
 14. Statement of whether batch is pre-mixed at plant or mixed in transit.
- B. Record of Placed Concrete: Submit record date, location of pour, quantity, air temperature, and Contractor's quality control test samples taken.
- C. Bonding Compound: Submit product name, type, and chemical analysis.
- D. A construction joint layout of exposed horizontal surfaces shall be submitted to and approved by the Engineer before beginning field layout and prior to placing concrete.

1.4 QUALITY ASSURANCE

- A. Remove and replace any placed concrete suffering hot or cold weather damage.
- B. For control testing follow APWA Section 03305 requirements.
- C. Prior to and during placement of reinforced structural concrete, Inspector shall inspect formwork, reinforcement, conduit embedments, anchor bolts, and other elements of the work in addition to concrete placement in compliance with the Project Quality Plan.

1.5 ACCEPTANCE

- A. Concrete work that fails to meet any of the following requirements will be considered defective and shall be replaced.
 1. Placement:
 - a. Reinforcing steel size, quantity, strength, position, damage, or arrangement is not as specified or does not comply with code.
 - b. Formwork differs from required dimensions or location in such a manner as to reduce concrete's strength or load carrying capacity or physical esthetics.
 - c. Workmanship likely to result in deficient strength.
 2. Finishing:

- a. Concrete exposed to view has defects that adversely affect appearance.
 - b. Slab tolerances of Section 03 35 10 are not met.
3. Protection:
- a. Method of curing is not as specified or approved by the Engineer.
 - b. Inadequate protection of concrete from temperature extremes during early stages of hardening and strength development.
 - c. Mechanical injury, construction fires, accidents, or premature removal of formwork likely to result in deficient strength development.

PART II - PRODUCTS

2.1 MATERIALS

- A. Concrete: Class as indicated, material per Section 03 15 16.
 1. For roadway cuts, refer to APWA Section 02985.
- B. Bonding Compound: Type II (Non-redispersible) polyvinyl acetate base or acrylic base latex per ASTM C 1059.
- C. Vapor Retarder: 10 mil thick clear polyethylene sheet. Type recommended for below grade application.
- D. Forms: Refer to Section 03 11 10.
- E. Reinforcement: Refer to Section 03 20 10.
- F. Coverings and Curing Compound: Refer to Section 03 39 00.
- G. Non-shrink Grout: As per APWA Section 03600, Article 2.5, Epoxy Adhesive Grout.
- H. Epoxy Adhesive: Refer to APWA Section 03600.
- I. Station Shade Structures and Marker. Refer to 03 31 00 Concrete Materials and Proportioning.
- J. Station Platform Concrete Work
 1. Expansion Joint Material:
 - a) Filler for expansion joints $\frac{1}{2}$ " or smaller shall be resilient bituminous premolded expansion joint material conforming to ASTM D 1751, width as shown in plans and described in Section 03 15 16.13.
 - b) Filler for expansion joints greater than $\frac{1}{2}$ ": ASTM D 1752 "Preformed Expansion Joint Fillers" (Non-Bituminous)
 - 1) Where required for support of expansion joint, sealant joint and joints indicated as "preformed joint filler". Type I gray sponge rubber

may be used.

- 2) At other locations, provide Type III self-expanding cork.
 - 3) Acceptable manufacturers: Meadows, Horn, Burke or approved equal.
- c) Where specifically called out on the plans, at joints where slabs are placed against concrete walls, or at joints requiring a bond breaker, a 40-pound asphalt saturated felt shall be used.
2. Cement Mortar:
- a) Use either standard premixed mortar conforming to ASTM C 387, or mortar proportioned with one part Portland Cement to two parts clean, well-graded sand which passes a 1/8" screen and which conforms to AASHTO M 45. Admixtures may be used, but do not exceed the following percentages of cement by weight: hydrated lime, 10%, and diatomaceous earth or other inert materials, 5%.

PART III - EXECUTION

3.1 PREPARATION

- A. Notify Engineer minimum 24-hours prior to commencement of concrete placement operations. (Notify testing agency, don't pour without inspection.)
- B. Do not allow construction loads to exceed member capacity.
- C. Clean previously placed concrete. Apply bonding compound per manufacturer's instructions.
- D. At locations where new concrete is dowelled to existing work, drill, insert and pack steel dowels with shrink compensating grout.

3.2 EXAMINATION

- A. Verify items to be cast into concrete are accurately placed and held securely.
- B. Verify slump range on delivery ticket matches mix design.
- C. Verify slab steel mats are supported by steel chairs, precast concrete blocks, or other slab bolsters. Do not pour if absent.

3.3 DELIVERY

- A. Slump: Keep slump within the allowable range.
- B. Placement Time:

Air Temperature

Less than 90, Deg. F.
Greater than 90 Deg. F.
Greater than 90 Deg. F.

Time After Initial Batching

1-1/2-hours
1-hour (without retarder)
1-1/2-hours (with retarder)

- C. Tempering:

1. When concrete arrives at site with slump below specified, water may be added if the maximum approved water/cement ratio and the maximum slump is not exceeded provided that;
 - a. The approved mix design has allowed for addition of water.
 - b. The amount of water added is accurately measured to one gallon of the desired added amount.
 - c. That water addition is followed by 3 minutes of mixing at mixing speed or 30 revolutions prior to discharge.
 2. Do not add water after concrete discharge from the delivery vehicle.
- D. Super-plasticizer: Comply with manufacturer's requirements. If none, then as follows:
1. If added at site, add agent using injection equipment capable of rapidly and uniformly distributing the admixture to the concrete. Prior to discharge, mix for a minimum of 5 minutes at a drum rate not less than 12 rpm or more than 15 rpm.
 2. If added at plant; do not deliver to site unless batch delivery ticket displays water/cement ratio prior to super-plasticizer addition.
 3. Tempering with super-plasticizer after expiration of allowable delivery times is prohibited.

3.4 CONCRETE PLACEMENT

- A. Place concrete per ACI 301.
1. Hot Weather Placement: Place per ACI 305. If the rate of evaporation approaches 0.2 lb./ft²/hr. precautions against plastic shrinkage cracking are necessary. (i.e. dampening subgrade and forms; placing concrete at the lowest possible temperature; erecting windbreaks and sunshades; fog sprays; use of evaporation retardants; or rescheduling time of placement).
 2. Cold Weather Placement: Place per ACI 306.1. Non-chloride accelerating admixture may be used in concrete work placed at ambient temperatures below 50 deg. F. Use of admixtures will not relax cold weather placement requirements.
- B. Concrete Temperature: Keep mixed concrete temperature at time of placement between 60 deg. F. and 90 deg. F.
- C. Do not disturb reinforcement, inserts, embedded parts, and formed joints.
- D. Do not break or interrupt successive pours such that cold joints occur.
- E. Honeycomb or embedded debris in concrete is not acceptable.
- F. Construction Joint Cleaning
- 1) Construction joints shall be cleaned by waterblasting, sandblasting or light bush-hammering after the concrete has reached its final set, unless modifications are permitted as specified below. The cleaning shall be continued until all unsatisfactory

concrete and all laitance, coating, stains, debris and other foreign materials are removed. The surface of the concrete shall be cleaned thoroughly to remove all loose material. Waterblasting equipment shall be operated at a pressure sufficient to permit cutting after the concrete has reached its final set.

3.5 JOINTS AND JOINT SEALING

- A. Section 03 15 16.13 and Section 32 13 73.

3.6 CONSOLIDATION

- A. ACI 309.
- B. Keep spare vibrator available during concrete placement operations.

3.7 FINISHING

- A. Section 03 35 10.
- B. Unless specified otherwise, finish as follows.
 - 1. Sidewalks, garage floors, and ramps: Broom or belt finish.
 - 2. Exterior concrete pavement: Broom or belt finish.
 - 3. Exterior platforms, steps, and landings, exterior and interior pedestrian ramps, not covered by other finish materials: Nonslip finish.
 - 4. Surfaces intended to receive bonded applied cementitious applications: Scratched finish.
 - 5. Surfaces intended to receive roofing, except future floors, waterproofing membranes, and roof surfaces that are future floors or sand bed terrazzo: Floated finish.
 - 6. Floors and roof surfaces that are floors intended as walking surfaces or to receive floor coverings: Troweled finish.
 - 7. Unpainted concrete surfaces not exposed to public view: Rough as-cast form finish.
 - 8. Unpainted concrete surfaces exposed to public view: Smooth as-cast form finish.
 - 9. Concrete surfaces to receive paint or plaster: Grout cleaned finish.

3.8 CURING

- A. Section 03 39 00.
- B. Use a membrane forming compound unless specified otherwise.

3.9 DEFECTIVE CONCRETE

- A. Modify or replace concrete not conforming to required levels, lines, details, and elevations.
- B. Structural analysis and additional testing may be required when the strength of a structure is

considered potentially deficient.

- C. Patch imperfection. Refer to **Section 03732** requirements.

3.10 PROTECTION AND REPAIRS

- A. Follow APWA Section 01 66 00 requirements.
- B. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury.
- C. Maintain concrete with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement and hardening of concrete.

3.11 NON-SHRINK GROUT AND DRYPACK

- A. Clean dust and foreign matter from area, then moisten concrete surfaces with clean water.
- B. Mix grout as recommended by manufacturer and stir until a smooth, creamy consistency is produced, using a minimum amount of water.
- C. Pour mixture into space until it overflows the hole.
- D. Wipe off excess, flush and level with adjacent surface, or as indicated.
- E. Keep surface moist for at least 30 minutes after placing.

3.12 PLACING CONCRETE UNDER WATER

- A. Place and deposit concrete under water when specified on the plans.
- B. Seal the forms or cofferdams watertight.
- C. Do not pump water while placing concrete or disturb the concrete until it has set at least 24 hours, or attained at least 50 percent of its design strength.
- D. Regulate placing to keep surfaces approximately horizontal at all times.
- E. Place the concrete by beginning at one end of the form and progressing in a zig-zag movement from side to side across the length of the form.
- F. Place the concrete using a tremie or concrete pumping equipment.
- G. Observe the following steps when placing concrete with a tremie:
 - 1. Use an 8-inch to 12-inch diameter steel tube tremie constructed with watertight connections, a hopper to receive concrete, and a device at the bottom to exclude water from entering the tube.
 - 2. Use support that permits the discharge end to move over the entire top work surface and permits the tremie to be rapidly lowered to stop or retard flow when necessary.
 - 3. Minimize the number of tremie location shifts for continuous placement.
 - 4. Keep the tremie tube full to the bottom of the hopper during placement.

5. Slightly raise the tremie when a batch is dumped into the hopper, but do not raise it out of the concrete at the bottom until the batch discharges to the bottom of the hopper. If the concrete seal around the tube is lost, re-plug the end and refill the tube with concrete.

PART IV - MEASUREMENT

- 4.1 **Measurement** – No Separate measurement will be made for Work described in this Section.

PART V - PAYMENT

- 5.1 **Payment** – Payment for items in this Section will be incidental to the Contract unit cost of the concrete bid items.

END OF SECTION

SECTION 03 31 10
CONCRETE MIXING, PLACING, JOINTING, AND CURING

PART 1 - GENERAL**1.1 SUMMARY**

- A. Furnish labor, materials, tools, equipment, and services for Concrete Mixing, Placing, Jointing and Curing as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

- A. Materials standards:
 - 1. ASTM C171 Standard Specification for Sheet Materials for Curing Concrete.
 - 2. ASTM C309 Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
 - 3. ASTM C1315 Standard Specification for Liquid Membrane Forming Curing Compounds Having Special Properties for Curing and Sealing Concrete.
 - 4. ASTM D1751 Standard Specification for Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types).
 - 5. ASTM D1752 Standard specification for Preformed Sponge Rubber and Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction.
 - 6. ASTM E1643 Standard Practice for Installation of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs.
 - 7. ASTM E1745 Specification for Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs
- B. Production standards:
 - 1. ASTM C94 Standard Specification for Ready-mixed Concrete.
 - 2. ASTM C138 Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete.
 - 3. ASTM C567 Standard Test Method for Determining the Density of Structural Lightweight Concrete.
 - 4. ACI 305.1 Hot Weather Concreting.
 - 5. ACI 306.1 Cold Weather Concreting.
 - 6. ACI 308 Standard Specification for Curing Concrete.
 - 7. ACI 309 Recommended Practice for Consolidation of Concrete.
 - 8. ACI 304R Guide for Measuring, Mixing, Transporting, and Placing Concrete.
 - 9. ACI 304..2R Placing Concrete by Pumping Methods

1.3 SUBMITTALS

- A. Shop drawings:
 - 1. Placement plans: Indicate proposed locations of construction joints and placement sequence.
 - 2. Screeding and finishing plan.
- B. Product Data:
 - 1. Vapor Retarder.
- C. Samples:
 - 1. Vapor Retarder and sealing products.
 - 2. Joint filler.

3. Waterstops.
- D. Project information:
 1. Joint filler technical data.
 2. Curing compound technical data.
 - a. Interior slabs: Include floor covering manufacturer's written approval for use.
 3. Waterstop technical data.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Strippable Curing Compound:
 1. Base:
 - a. Kurez DR VOX or Kurez W VOX by Euclid Chemical Company.
 - b. Horncrete WB, Horncrete WB 30 by Tamms.
- B. Chemical Curing Compound :
 1. Base:
 - a. L&M Construction Chemicals.
 2. Optional:
 - a. Dayton Superior.
 - b. Euclid.
 - c. Sonneborne.
 - d. WR Meadows.
- C. Curing Sheet Material
 1. Base
 - a. Hydracure M5 by PNA Construction Technologies, Inc., Matthews,
 - b. Transguard 4000 by Reef Industries (Armorlon Division), Incorporated,
- D. Concrete Cleaner:
 1. Base:
 - a. ProSoCo.
 2. Optional:
 - a. L&M Construction Chemicals
- E. Self-Expanding Rubber Strip Waterstops:
 1. Base:
 - a. Greenstreak.
 2. Optional:
 - a. Progress Unlimited, Inc.
 - b. Deneef Construction Chemicals.
 - c. Adeka (Mitsubishi).
- F. Vapor Retarders: As noted.
- G. Other manufacturers desiring approval comply with Section 00 26 00.

2.2 MATERIALS

- A. Concrete materials and proportioning: See Section 03 31 00.
- B. Expansion joint filler, premolded: Type required, conforming to ASTM D1751 or ASTM D1752.
- C. Strippable Curing Compound:
 1. Conform to ASTM C309 (Voc Compliant, 350 g/l).
 2. For use on slabs receiving subsequent applied finishes and where noted on the drawings.

3. Install in strict accordance with the manufacturer's recommendation and supervision.
- D. Curing Sheet Material:
1. Provide where concrete is scheduled to be stained per section 09 67 75.
 2. Moisture-Retaining Cover Conforming to ASTM C171: Naturally colored, non-woven polypropylene fabric with a 4-mil non-perforated reflective (white) polyethylene coating.
 3. Fabric shall exhibit low permeability and high moisture retention.
- E. Granular Fill: See Section 31 23 00.

2.3 UNDER-SLAB VAPOR RETARDER

- A. Under-slab Vapor Retarder, Class A:
1. Meet ASTM E1745 Class A and:
 - a. Maximum Water Vapor Permeance: 0.01 Perms (US).
 - b. Minimum Tensile Strength: 45 FT-LB/IN.
 - c. Minimum Puncture resistance: 2300 Grams, minimum.
 2. Base Product:
 - a. Perminator - 15 mil by WR Meadows
- B. Optional Products:
1. 15-mil Green by Reef Griffolyn
 2. Vapor Block 15 by Raven
 3. Moistop Ultra 15 by Fortifiber
 4. Florprufe 120 by Grace
 5. Stego Wrap 15-mil Class A by Stego
 6. 15-mil Yellow Guard by Poly-America
- C. Tape as recommended by vapor retarder manufacturer.
- D. Other manufacturers desiring approval comply with requirements of Section 00 26 00.

2.4 WATERSTOPS

- A. Self-Expanding Rubber Strip Waterstops:
1. Bentonite-free hydrophilic polymer modified chloroprene rubber, suitable for adhesive bonding to concrete.
 2. Profile: Rectangular or trapezoidal strip unless otherwise indicated.
 3. Minimum Dimensions: 3/8 IN by 3/4 IN thick.
 4. Provide in maximum practicable length to minimize end joints.
 5. Butt splice joints at intersections and at ends of pieces in accordance with manufacturer's instructions.
 - a. Make joints to develop effective water tightness fully equal to that of continuous waterstop material, to permanently develop not less than 50 percent of mechanical strength of parent section, and permanently retain flexibility.
 6. Base Products: Hydrotite by Greenstreak; Ultra Seal by Adeka (Mitsubishi); Swellseal by Deneef Construction Chemicals; Superstop by Progress Unlimited, Inc

PART 3 - EXECUTION

3.1 MIXING AND PRODUCTION OF CONCRETE

- A. Batch, mix and transport ready-mixed concrete in accordance with ASTM C94.
1. Plant equipment and facilities shall conform to Check List for Certification of Ready Mixed Concrete Production Facilities of National Ready Mixed Concrete Association.

- B. Site batched and mixed concrete will be permitted only after ability to control quality has been demonstrated to satisfaction of Architect.

3.2 MIXING - CONTROL OF ADMIXTURES

- A. Admixtures shall be added in accordance with Manufacturers recommendations.
B. If two or more admixtures are used, verify compatibility with manufacturers.

3.3 MIXING - TEMPERING AND CONTROL OF MIXING WATER

- A. Mix concrete only in quantities for immediate use. Discard concrete which has set.
B. When concrete arrives at project with slump below that suitable for placing, water may be added only if neither maximum permissible water-cement ratio nor maximum slump is exceeded.
1. Incorporate water by additional mixing equal to at least half of total mixing required.
 2. Do not add water after discharge commences

3.4 MIXING - WEATHER CONDITIONS

- A. Cold weather:
1. Comply with ACI 306.
 2. In cold weather, temperature of concrete when delivered at site shall conform to following limitations:
 3. For sections with least dimension greater than 36 IN, comply with table 3.1 of ACI 306R

Minimum Concrete Temperature Required at Time of Pour		
Air Temperature @ time of pour	For sections with least dimension less than 12 IN	For sections with least dimension 12 IN to 36 IN
Above 30 DegF	60 DegF	55 DegF
0 to 30 DegF	65 DegF	60 DegF
Below 0 DegF	70 DegF	65 DegF

Minimum Concrete Temperature Required within 24 Hours of Pour		
Air Temp within 24 Hours of pour	For sections with least dimension less than 12 IN	For sections with least dimension 12 IN or greater
Below 32	60 DegF	50 DegF

4. If water or aggregate is heated above 100 DegF, combine water with aggregate in mixer before cement is added.
 - a. Do not mix cement with water or with mixtures of water and aggregate having a temperature greater than 100 DegF.
 - b. Final temperature of combined mix shall not exceed 90 DegF or be high enough to cause flash set or loss of slump or workability.
- B. Hot weather:
1. Comply with ACI 305 if high temperature, low slump, flash set, or cold joints are encountered.
 2. Cool ingredients before mixing, or add flake ice or well-crushed ice of a size that will melt completely during mixing for all or part of mixing water. Account for water contribution by ice when calculating the quantity if mixing water and insure that specified W/C ration is not exceeded.

3.5 PREPARATION BEFORE PLACING

- A. Equipment:

1. Remove hardened concrete and foreign material from inner surfaces of conveying equipment.
 2. Provide spare vibrator on job site during concrete placing operations.
 3. In cold weather, have protective blankets ready and heaters operational and in-place before placing concrete.
- B. Forms:
1. Complete formwork: Remove frost, snow, ice, water and foreign material; secure reinforcement in place, position expansion joint material, anchors, and other embedded items and have entire preparation inspected prior to concrete placement.
 2. In hot weather when temperature of reinforcing or forms is greater than 120 degF spray forms and reinforcement with water just prior to placing concrete.
- C. Screeds and screed rails:
1. General:
 - a. Develop a screed system to accurately strike off fresh concrete to the surfaces defined on drawings.
 - b. Anticipate deflection of formwork and support systems.
 - 1) Provide and place extra concrete as necessary to produce finish surfaces with specified tolerances at designated elevations and contours at no additional cost to the Owner.
 - c. When form work is cambered whether shored or un-shored and screeding is performed perpendicular (i.e., up and over) to crown of camber set screed rails to follow camber and provide a slab of uniform thickness.
 - 1) When screeding parallel with the camber set one screed at midspan along crown of camber and one along girder or support.
 - 2) Two passes of the screed is necessary to cover one full bay.
 - d. Other screeding methods may be used provided deflection of un-shored formwork is taken into consideration.
 - e. On unshored steel framing systems, accurately strike off concrete to produce a level surface after steel supporting system has deflected due to dead weight of fresh concrete.
 - f. Slab thickness on cambered steel shall not be less than that indicated on plan.
 - g. If not required in documents and subjected to approval of Architect, Contractor as option may camber formwork.
 - h. All concrete shall be struck off with a vibrating screed.
 - i. Use of a wet screed system will not be permitted unless:
 - 1) Concrete is struck with a pneumatically vibrated floater screed.
 - 2) A highway straight edge is used to true the surface perpendicular to direction of screeding.
 - 3) A satisfactory finish is produced on a trial slab.
 - j. Submit a screeding and finishing plan for approval.
 - 1) A representative trial slab pour shall be provided to demonstrate that the specified tolerances and a satisfactory surface can be provided by the proposed method of screeding and finishing.
- D. Subgrade for slabs on grade:
1. Subgrade shall be well drained and of adequate and uniform load bearing nature.
 - a. Keep in-place density of subgrade soils at least to minimum indicated.
 2. Keep subgrade free of frost before concrete placing begins.
 - a. If temperature inside a building where concrete is to be placed is below freezing, raise temperature and maintain above 50 degF long enough to remove frost from subgrade and reinforcing.
 3. Keep subgrade moist at time of concreting.
 - a. If necessary, dampen with water in advance of concreting.

- b. Allow no free water standing on subgrade nor muddy or soft spots when concrete is placed.

3.6 UNDER-SLAB VAPOR RETARDER

- A. Place continuous vapor retarder over granular fill.
 1. See Section 31 23 00.
 2. Installation as recommended by manufacturer.
- B. Comply with ASTM E1643 Standard Practice for Selection, Design, Installation, and Inspection of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs.
 1. Lap vapor retarder at ends and edges of sheets and seal with vapor retarder tape.
 2. Extend to extremities of area.
 3. Turn up at perimeter walls to form bond breaker and tape in place.
 4. Detail sleeved or drilled penetrations as recommended by manufacturer.
 - a. Coordinate detailing at penetrations with subcontractors responsible for penetrations.
- C. Protect vapor retarder. Repair punctures, tears and other damage using vapor retarder tape.
- D. Trim excess material after slab is placed.
- E. Inspect and approve vapor retarder installation prior to concrete placement.
 1. See Section 01 45 23.

3.7 PROTECTION

- A. Unless adequate protection is provided and approval is obtained, do not place concrete when temperature is below freezing or during rain, sleet or snow.
- B. Do not allow rainwater to increase mixing water nor to damage surface finish.
- C. Concrete damaged by rain or weather and judged defective by Architect shall be removed and replaced by Contractor at no additional cost to Owner or corrected by procedures listed in Section 03 08 16.

3.8 CONVEYING

- A. Handle concrete from mixer to place of final deposit as rapidly as practicable by methods which prevent segregation or loss of ingredients and assure that quality is maintained.
- B. Use equipment conforming to ASTM C94.
- C. Use horizontal belt conveyors or mount at a slope which will not cause excessive segregation or loss of ingredients.
 1. Protect concrete against undue drying or rise in temperature.
 2. Handle to prevent segregation.
 3. Do not allow mortar to adhere to belt.
 4. Discharge long runs into a hopper or through a baffle.
- D. Use metal or metal-lined chutes with slope between 1 vertical and 2-3 horizontal.
 1. Chutes more than 20 FT long and chutes not meeting slope requirements may be used provided they discharge into a hopper before distribution.
- E. Pumping or pneumatic conveying equipment shall be of suitable kind with adequate pumping capacity.
 1. Control pneumatic placement so that segregation is not apparent in discharged concrete.
 2. Loss of slump in pumping or pneumatic conveying equipment shall not exceed 2 IN.
 3. Do not convey concrete through pipe made of aluminum or aluminum alloy.

3.9 DEPOSITING IN FORMS

- A. Work includes:
 - 1. Deposit concrete continuously or in layers of such thickness that no concrete is deposited on concrete which has hardened sufficiently to cause formation of seams or planes of weakness within section.
 - 2. Place at such a rate that concrete which is being integrated with fresh concrete is still plastic.
 - 3. Do not deposit concrete which has partially hardened or has been contaminated by foreign materials.
 - 4. Remove temporary spreaders in forms when concrete placing has reached an elevation rendering their service unnecessary.
 - 5. They may remain embedded in concrete only if made of metal or concrete and if prior approval has been obtained.
- B. Do not start placing concrete in supported elements until concrete previously placed in columns and walls is no longer plastic and has been in place at least two hours.
- C. Deposit concrete as nearly as practicable in its final position to avoid segregation due to re-handling or flowing.
 - 1. Do not subject concrete to procedure which will cause segregation.
 - 2. Concrete shall not drop more than 6 FT unless approved by the Architect/Engineer. For greater heights, provide special mix design, chutes, spouts, tremies, or other approved method.
- D. Concrete buckets shall be equipped with rubber discharge tubes.
 - 1. Tube size shall be effective in directing flow of concrete directly downward between reinforcing.
 - 2. Unless it can be demonstrated, no segregation will occur with greater distances, maximum free fall distance of concrete below flexible tube is limited to 4 FT.
- E. Consolidation:
 - 1. Consolidate concrete by vibration, so that concrete is thoroughly worked around reinforcement, around embedded items and into corners of forms eliminating air or stone pockets which may cause honeycombing, pitting, or planes of weakness.
 - 2. Use internal vibrators having a minimum frequency of 8000 vibrations per minute to consolidate concrete effectively.
 - 3. Do not use vibrators to transport concrete within forms.
 - 4. Insert vibrators and withdraw at points approximately 18 IN apart.
 - 5. At each insertion allow duration sufficient to consolidate concrete but not sufficient to cause segregation; generally from 5 to 15 sec.
 - 6. Where concrete is to have an as-cast finish, bring a full surface of mortar against form by vibration process, supplemented if necessary by spading, to work coarse aggregate back from formed surface.

3.10 SLAB PLACEMENT

- A. Coordinate mixing and placing with finishing.
 - 1. Do not place concrete on subgrade or forms more rapidly than it can be spread, straight edged, and darbled or bull floated.
 - 2. Perform these operations before bleed water has an opportunity to collect on surface.
- B. To obtain good surfaces and avoid cold joints, plan size of finishing crews with due regard for effects of concrete temperature and atmospheric conditions on rate of hardening of concrete.
 - 1. If construction joints become necessary, construct as required under joints and embedded items.
- C. Consolidation:

1. Thoroughly consolidate concrete in slabs.
2. Use internal vibration in beams and girders of framed slabs and along bulkheads of slabs on grade.
3. Obtain consolidation of slabs with vibrating screeds, roller pipe screeds, internal vibrators, or other approved means.

3.11 JOINTS AND EMBEDDED ITEMS

- A. Construction joints, other than slab on grade:
 1. Locate joints not indicated so as to least impair strength of structure.
 - a. Place joints in locations approved by Architect/Engineer.
 2. In general, locate near middle of spans of slabs, beams, and girders unless a beam intersects a girder at this point, in which case, offset joint in girder a distance equal to twice width of beam.
 - a. Locate joints in walls and columns at underside of floors, slabs, beams, or girders and at tops of footings or floor slabs.
 - b. Place beams, girders, brackets, column capitals, haunches, and drop panels at same time as slabs.
 - c. Make joints perpendicular to main reinforcement.
 3. Continue reinforcement across joints.
 4. Clean surface of concrete at joints thoroughly and remove laitance.
 - a. Prior to placing adjoining concrete, dampen (but do not saturate) hardened concrete of construction joints.
- B. Joints in slabs-on-grade:
 1. Construction joints:
 - a. Place keyed dowelled or diamond plate construction joints as indicated on plans and at locations where a slab placement is terminated or interrupted.
 - b. Size of placements and sequence of slab placement is Contractor's option, except construction joints shall be located at a control joint location.
 - c. Construction joints act as control joints.
 2. Control joints:
 - a. Provide contraction (control) joints as indicated.
 - b. If not shown, provide along column centerlines.
 3. Control joints:
 - a. Where column centerline spacing or spacing between column centerlines and walls exceeds 30 FT, provide an intermediate joint(s) at intervals not exceeding 30 FT.
 - b. Locate joints to produce panels that are as square as possible with length not exceeding 1.5 times width.
 - c. Also provide joints where change in slab width occurs, such as at block-outs, pits, etc.
 - d. If saw cut joints are required or permitted, time cutting properly with set of concrete by one of the following methods
 - 1) Start cutting as soon as concrete has hardened sufficiently to prevent aggregates being dislodged by saw. Complete sawing within 12 hours after placement.
 - 2) The soff cut saw shall be used within two hours of final finishing.
 - a) Cut depth not less than 10 percent of slab thickness with a 1-inch minimum.
 - b) Remove debris in path of cut and under Skid Plate before cutting. Skid Plate must remain flat on surface.
 - c) Use Soff-Cut blades and Skid Plates, using a new Skid Plate with each new blade.
 - d) Install Soff-Cut joint protector at saw-cut intersection prior to cross-cut.
 - e) Remove dry powder without disturbing finish.

- f) Avoid traffic across saw cut until sufficient strength is gained to protect joint edges.
- 3) If an alternate method or timing is proposed, submit detailed plans for review and acceptance.
- 4. Complete before shrinkage stresses become sufficient to produce cracking.
- 5. Isolation joints:
 - a. Provide isolation joints around columns, and between slab on grade and walls.
 - b. Also provide isolation joints around equipment or machinery isolation pads, pits, pipes, etc., unless detailed otherwise.
- C. Expansion joints:
 - 1. Do not permit reinforcement or other embedded metal items bonded to concrete, except dowels in floors bonded on only one side of joints, to extend continuously through expansion joint.
 - 2. Locate expansion joints as indicated.
- D. Acoustic Isolation Joint:
 - 1. Do not permit any reinforcing or other bonded items to extend through joint.
 - 2. Remove forming material and clean joint thoroughly prior to cover installation. Locate as indicated.
- E. Place sleeves, inserts, anchors, and embedded items required for adjoining work or for its support, prior to placement of concrete.
 - 1. Give Contractors whose work is related to concrete or supported by it ample notice and opportunity to introduce and/or furnish embedded items before concrete placement.
 - 2. Position expansion joint material, waterstops, and other embedded items accurately and support against displacement.
 - 3. Fill voids in sleeves, inserts and anchor slots temporarily with readily removable material to prevent entry of concrete.

3.12 BONDED JOINTS

- A. At construction joints indicated as bonded, obtain bond by one of following methods:
 - 1. Roughen surface of concrete in an approved manner which will expose aggregate uniformly and not leave laitance, loosened particles of aggregate or damaged concrete at surface.
 - a. Dampen (but do not saturate) hardened concrete of joints in exposed work; joints in middle of beams, girders, joists, and slabs; and joints in work designed to contain liquids.
 - b. Thoroughly cover with a coat of cement grout of similar proportions to mortar in concrete.
 - c. Use grout as thick as possible on vertical surfaces and at least 1/2 IN thick on horizontal surfaces.
 - d. Place fresh concrete before grout has attained its initial set.
 - 2. Prepare joints receiving an adhesive and apply adhesive in accordance with manufacturer's recommendations prior to placing of fresh concrete.
 - 3. Prepare surfaces of joints which have been treated with a chemical retarder in accordance with manufacturer's recommendations prior to placing of fresh concrete.

3.13 SLAB FINISHING

- A. See Section 03 35 00.

3.14 CURING AND PROTECTION

- A. Work includes: Beginning immediately after placement, protect concrete from premature drying, hot or cold temperatures, and mechanical injury, and maintain with minimal moisture loss at relatively constant temperature for period necessary for hydration and hardening of concrete. Materials and methods of curing subject to approval.
- B. Preservation of Moisture:
1. Interior Slabs:
 - a. Application of sheet curing materials.
 - b. Application of strippable curing compound.
 - 1) Submit written approval from floor covering manufacturer prior to use.
 - 2) Apply in accord with recommendations of manufacturer immediately after water sheen, which may develop after finishing, has disappeared.
 - 3) Apply continuous film at manufacturer's specified rate.
 - 4) Completely remove prior to application of floor covering material.
 2. Other concrete surfaces not in contact with forms apply one of following procedures immediately after completion of placement and finishing:
 - a. Ponding or continuous sprinkling.
 - b. Application of absorptive mats or fabric kept continuously wet.
 - c. Application of sand kept continuously wet.
 - d. Continuous application of mist spray, not exceeding 150 degF.
 - e. Application of sheet curing materials.
 - f. Application of other moisture-retaining covering as approved.
 - g. Application of curing compound.
 - 1) Apply in accord with recommendations of manufacturer immediately after water sheen, which may develop after finishing, has disappeared.
 - 2) Apply continuous film at manufacturer's specified rate.
 - 3) Do not use on surface against which additional concrete or other material is to be bonded, unless it is proven that curing compound will not prevent bond or positive measures are taken to remove curing compound completely from areas to receive bonded applications.
 3. Minimize moisture loss from surfaces placed against wooden forms or metal forms exposed to heating by sun by keeping forms wet until they can be safely removed.
 - a. After form removal cure concrete until end of time prescribed.
 4. Continue curing in accordance with ACI 318. Seven days for most concrete.
 - a. If tests made of cylinders, kept adjacent to structure and cured by same methods, indicate average compressive strength has reached 70 percent of specified strength, (f_c'), moisture retention methods may be terminated.
 - b. If one of curing procedures indicated above is used initially, it may be replaced by one of other procedures indicated any time after concrete is 1 day old, provided concrete is not permitted to become surface dry during transition.
- C. Temperature, wind and humidity:
1. Cold weather:
 - a. When mean daily outdoor temperature is less than 40 degF maintain temperature of concrete between 50 and 70 degF for required curing period.
 - b. When necessary make arrangements for heating, covering, insulating, or housing concrete work adequate to maintain required temperature without injury.
 - c. Do not use combustion heaters during first 24 hours unless precautions are taken to prevent exposure of concrete to exhaust gases which contain carbon dioxide.
 2. Hot weather:
 - a. When necessary make provision for windbreaks, shading, fog spraying, sprinkling, ponding, or wet covering with a light colored material.

- b. Take such protective measures as quickly as concrete hardening and finishing operations will allow.
- 3. Rate of temperature change:
 - a. Keep changes in temperature of air immediately adjacent to concrete during and immediately following curing period as uniform as possible.
 - b. Do not exceed 5 degF in any 1 hour or 50 degF in any 24-hour period.
- D. Protection from mechanical injury:
 - 1. During curing period, protect concrete from damaging mechanical disturbances, such as load stresses, heavy shock, and excessive vibration.
 - 2. Protect finished concrete surfaces from damage by construction equipment, materials, or methods, and by rain or running water.
 - 3. Do not load self-supporting structures in such a way as to overstress concrete.
- E. Protection of slabs-on-grade from frost:
 - 1. Interior slabs exposed to freezing temperatures shall be adequately protected so that frost does not develop in supporting subgrade.

3.15 ELEVATOR DOOR FRAMES

- A. Elevator Door Frames in concrete shafts:
 - 1. Block-out as required by Elevator Manufacturer to allow for door frames to be set.
 - 2. After door frames have been set, set forms across void between frame and edge of block-out.
 - 3. Fill in with concrete fill.

3.16 CONCRETE CLEANING

- A. Clean Cast-in-Place concrete walls which will remain exposed to view.
 - 1. Including walls which are scheduled for painting.

END OF SECTION

SECTION 03 35 00**CONCRETE FINISHING AND REPAIR OF SURFACE DEFECTS****PART 1 - GENERAL****1.1 SUMMARY**

- A. Furnish labor, materials, tools, equipment, and services for Concrete Finishing and Repair of Surface Defects, as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

- A. Floor finish tolerances:
 - 1. Follow F-Number System as defined in ASTM E1155.
 - a. Floor Flatness F-Number: F_F defines maximum floor curvature allowed over 24 IN computed on basis of successive 12 IN elevation differentials.
 - b. Floor Levelness F-Number: F_L defines relative conformity of floor surface to a horizontal plane measured over a 10 FT distance.
 - c. Above number pair to be stated in form: F_F/F_L .
 - d. Specified overall value is enumerated and is based on composite of measured values in a placement.
 - e. Minimum local value (MLV) describes flatness or levelness below which repair or replacement is required. MLV is based on individual placement and applies to minimum local area not crossing construction or control joints.

PART 2 - PRODUCTS**2.1 MATERIALS**

- A. Bonding agent: Approximately one (1) part Portland cement to one (1) part fine sand passing a No.30 mesh sieve. Mix to consistency of thick cream.
- B. Patching compound: Same materials and approximately same proportions as used for concrete, except omit coarse aggregate. Shall consist of not more than one (1) part Portland cement to two and one half (2-1/2) parts sand loose volume. For exposed concrete, part of Portland cement shall be white to produce a color matching color of surrounding concrete, as determined by a trial patch. Add no more water than necessary for handling and placing. Mix compound in advance and allow to stand with frequent manipulation, without addition of water, until it has reached stiffest consistency that will permit placing.
- C. Grout for grout cleaned rubbed finish: Mix one (1) part Portland cement and one and one-half (1-1/2) parts fine sand with sufficient water to produce a grout with a consistency of thick paint.
- D. Grout for cork floated rubbed finish: Mix one (1) part Portland cement and one (1) part fine sand with sufficient water to produce a stiff grout.
- E. Proprietary materials: At Contractor's option, proprietary compounds for adhesion, patching, or finishing may be used in lieu of or in addition to foregoing grouts. Use such compounds in accordance with manufacturer's recommendations.
- F. Chemical hardener:
 - 1. Base manufacturer:

- a. Sonneborn Building Products.
2. Optional manufacturer:
 - a. Pro-Tex-All.
3. Other manufacturers desiring approval comply with Section 00 26 00.

PART 3 - EXECUTION

3.1 FINISHING - GENERAL

- A. After removal of forms, repair and give surfaces of concrete finishes indicated.
 1. Top surface of slabs not included.
- B. Unspecified finish: If finish is not designated, use following finishes as applicable:
 1. Unpainted concrete surfaces not exposed to public view: Rough form finish.
 2. Unpainted concrete surfaces exposed to public view: Smooth form finish.
 3. Concrete surfaces to receive paint: Grout cleaned rubbed finish.
 4. Unformed surfaces (except slabs): As indicated.
 5. Concrete surfaces to be waterproofed in Section 07 14 13 and Section 07 14 16: Smooth form finish.

3.2 REPAIR OF SURFACE DEFECTS

- A. Repair surface defects immediately after form removal. Remove honeycombed and other defective concrete down to sound concrete. Chip if necessary to make edges perpendicular to surface or slightly undercut. No feather edges will be permitted. Dampen area to be patched and an area at least 6 IN wide surrounding it to prevent absorption of water from patching compound. After surface water has evaporated from area to be patched, brush bonding agent into surface. When bonding agent begins to lose water sheen, apply patching compound. Thoroughly consolidate compound into place and strike off so as to leave patch slightly higher than surrounding surface. To permit initial shrinkage, leave undisturbed for at least 1 HR before final finish. Keep patched area damp for 7 days. Do not use metal tools in finishing a patch which will be exposed.
- B. Tie holes: Unless stainless steel, non-corrosive, or acceptably coated ties are used, tie holes shall be filled. Clean and thoroughly dampen tie holes; fill solid with patching compound.

3.3 AS-CAST FINISHES

- A. Rough form finish: No selected form facing materials are specified for rough form finish surfaces. Concrete surfaces must conform to tolerances in Section 03 11 00 Concrete Formwork. Patch defects and tie holes. Chip or rub off fins exceeding 1/4 IN in height. Otherwise, leave surfaces with texture imparted by forms.
- B. Smooth form finish: Use form facing material to produce a smooth, hard, uniform texture on concrete. It may be plastic coated plywood, metal, plastic liners, or other approved material capable of producing desired finish. Arrange facing material orderly and symmetrical, with number of seams kept to practical minimum. Support by studs or other backing capable of preventing excessive deflection. Do not use material with raised grain, patches, or other defects which will impair texture of concrete surface.
 1. Patch tie holes and defects. Remove fins completely.
 2. When surface texture is impaired and form joints misaligned by more than 1/8 IN grind bushhammer, or correct affected concrete as directed by Architect. Slurry grout areas evidencing minor mortar leakage to match adjacent concrete. Repair major mortar leakage as a defective area.
- C. Special architecture finish: Produce finish in accord with requirements of Section 03 45 00, Architectural Precast Concrete.

- D. Finishing of related unformed surfaces: (Except Slabs).
1. Strike smooth tops of walls or buttresses, horizontal offsets, and similar unformed surfaces occurring adjacent to formed surfaces after concrete is placed.
 2. Float to a texture reasonably consistent with that of formed surfaces.
 3. Continue final treatment on formed surfaces uniformly across unformed surfaces.

3.4 RUBBED FINISHES

- A. General: Form and repair concrete surfaces to receive rubbed finishes, in accordance with requirements for smooth form finish. Remove forms and perform necessary patching as soon after placement as possible without jeopardizing structure.
- B. Smooth: Produce smooth rubbed finish on newly hardened concrete no later than day following form removal. Wet surfaces and rub with carborundum brick or other abrasive until uniform color and texture are produced. Use no cement grout other than cement paste drawn from concrete itself by rubbing process.
- C. Grout cleaned: Undertake no cleaning operations until contiguous surfaces are completed and accessible. Wet surface of concrete sufficiently to prevent absorption of water from grout and apply grout uniformly. Immediately after applying grout, scrub surface vigorously with a cork float or stone to coat surface and fill air bubbles and holes. While grout is still plastic, remove excess grout by working surface with a rubber float, sack, or other means. After surface whitens from drying, rub vigorously with clean burlap. Keep finish damp for at least 36 hours after final rubbing.
- D. Cork floated: Remove forms at an early stage, within 2 to 3 days of placement where possible. Remove ties. Remove burrs and fins. Dampen wall surface. Apply grout with firm rubber float or with trowel, filling surface voids. Compress grout into voids. If grout surface dries too rapidly to permit proper compaction and finishing, apply a small amount of water with a fog sprayer. Produce final texture with a cork float using a swirling motion.

3.5 SLAB FINISHING

- A. General:
1. Place slabs to finish tolerances specified.
 2. Slab finish: Use following finishes at building locations noted.
 - a. Scratched finish: Surfaces intended to receive bonded applied cementitious applications, such as setting beds, grout, etc.
 - b. Floated finish (magnesium):
 - 1) Surfaces intended to receive roofing, waterproofing membranes, or sand bed terrazzo.
 - 2) Surfaces of ramps, docks, stairs in which no other covering is specified.
 - c. Broom or Belt finish: Parking garage floors.
 - d. Troweled finish:
 - 1) Floors intended as walking surfaces or to receive floor coverings.
 - e. Non-slip finish (interior and exterior): Ramps, docks, stairs specifically noted on drawings.
- B. Finishing tolerances:
1. For shored construction, measurements for conformance with finishing tolerances shall be made as soon as slab can tolerate foot traffic, and before shores are removed.
 2. The FI levelness tolerance is not applicable to unshored form work such as cast in place topping on prestressed tees, slabs on unshored steel and metal deck, or unshored-postensioned slabs on steel beams.
 3. Horizontal finishes will be accepted provided:
 - a. Applicable specification requirements are satisfied.
 - b. Water does not pond in areas sloped to drain.

- c. Floor finish tolerances Ff/FI conforms to that specified for particular finish and minimum local valves are not less than 75 percent of the floor finish tolerance specified.
 4. Accumulated deviation from intended true plane of finished surface does not exceed 1 IN.
 5. Accuracy of floor finish does not adversely affect installation and operation of movable equipment, floor supported items or items fitted to floor (doors, tracks, etc.).
- C. Finishes:
1. Scratched finish: After concrete has been placed, consolidated, struck off, and leveled to a Ff15/FI13 tolerance, roughen surface with stiff brushes or rakes before final set.
 2. Floated finish: After concrete has been placed, consolidated, struck off, and leveled, do not work further until ready for floating. Using a magnesium float, begin floating when water sheen has disappeared and surface has stiffened sufficiently to permit operation. During or after first floating, check planeness of entire surface with a 10 FT straightedge applied at not less than two different angles. Cut down high spots and fill low spots during this procedure to produce a surface within Ff25/FI20 tolerance throughout, unless otherwise noted as "superflat". Where noted as "superflat" on plan provide Ff60/FI55. Refloat slab immediately to a uniform sandy texture.
 3. Troweled finish: First float-finish surface. Next power trowel, and finally hand trowel. First troweling after power floating shall produce a smooth surface which is relatively free of defects but which may still indicate some trowel marks. Perform additional troweling by hand after surface has hardened sufficiently. Final trowel when a ringing sound is produced as trowel is moved over surface. Thoroughly consolidate surface by hand troweling. Leave finished surface essentially free of trowel marks, uniform in texture and appearance and plane to a Ff25/FI20 tolerance unless otherwise noted as "superflat". Where noted as "superflat" on plan provide Ff60/FI55. On surfaces intended to receive floor coverings, grind off defects which would indicate through floor covering. On surfaces intended to receive waterproofing membranes grind off defects that might tear or otherwise damage membrane.
 4. Broom or belt finish: Immediately after concrete has received float finish, give it a coarse scored texture by drawing a broom or burlap belt across surface transverse to slope or traffic flow.
 5. Non-slip slab finish:
 - a. Aggregate: Crushed ceramically bonded aluminum oxide particles. Apply at 25 LB per 100 SF.
 - b. Blend aggregate with Portland cement in proportions recommended by manufacturer of aggregate.
 - c. Give surface a float finish.
 - d. Apply approximately two-thirds of blended material for required coverage to surface by a method that ensures even coverage without segregation. Begin floating immediately.
 - e. After material has been embedded by floating, apply remainder of blended material to surface at right angles to previous application. Make second application heavier in areas not sufficiently covered by first application. Follow with second floating immediately.
 - f. After selected material has been embedded by two floatings, complete operation with a broomed finish.

END OF SECTION

SECTION 03 35 10**CONCRETE FINISHING****PART I - GENERAL****1.1 SUMMARY**

- A. Description: This work includes concrete finishing requirements and methods.

1.2 REFERENCES

- A. ACI 303: Guide to Cast-in-Place Architectural Concrete Practice.

1.3 SUBMITTALS

- A. Name, type, chemical analysis and manufacturer's recommended rate of application for liquid chemical hardener.

1.4 PROJECT CONDITIONS

- A. Protect adjacent materials and finishes from dust, dirt and other surface or physical damage during finishing operations. Provide protection as required and remove from site at completion of Work.

1.5 QUALITY ASSURANCE

- A. Provide full-scale mock up showing finishes as indicated in the Drawings for the items listed below. The mock-up shall be located at a stop to be determined by the Owner. Approved mock-up will be incorporated into the Work.
 - a. Seat Wall
 - b. Platform flatwork

PART II - PRODUCTS**2.1 MATERIALS**

- A. Dry Shake: Blend of metallic or mineral aggregate with Portland cement concrete in proportions recommended by manufacturer Liquid-Chemical
- B. Proprietary Materials: If permitted or required, proprietary compounds may be used in lieu of or in addition to foregoing materials. Use such compounds per manufacturer's recommendations.
- C. Hardener: Colorless, aqueous solution containing a blend of magnesium fluosilicate, zinc fluosilicate and a wetting agent. Mixture contains not less than 2 pounds fluosilicate per gallon and does not interfere with adhesives and bonding.
- D. Aggregate: Course (Exposed) Aggregate Concrete Slab Finishes
 - a. ASTM C33, washed, clean, graded No. 3 Fine Ballast Aggregate
- E. Sand: Course (Exposed) Aggregate Concrete Slab Finishes:
 - a. Coral Sand

- F. Commercial Packing Mortar: A structural repair mortar may be furnished if appropriate and approved by the Owner

PART III - EXECUTION

3.1 PREPARATION

- A. Examine the areas and conditions under which work of this section will be performed.
- B. Correct conditions detrimental to timely and proper finishing.
- C. Do not proceed until unsatisfactory conditions are corrected.

3.2 FINISHING HORIZONTAL SLABS

- A. Do not apply water (i.e. sprinkle) to any surface of concrete when finishing slabs.
- B. Slab finishing tolerances.
1. Class A finish: 1 in 1000.
 2. Class B finish: 1 in 500.
 3. Class C finish: 1 in 250.
- C. Floated Finish: After concrete has been placed, consolidated, struck-off, and leveled, do not work further until ready for floating.
1. Begin floating when water sheen has disappeared and surface has stiffness sufficient to permit operation.
 2. During or after first floating, check planeness of entire surface with a 10-foot long straightedge applied at 2 or more different angles. This step is not required for structures to be covered by fill or ballast.
 3. Cut down high spots and fill low spots to the required tolerance.
 4. Refloat slab immediately to a uniform sandy texture.
- D. Trowel Finish:
1. Float finish surface.
 2. Power trowel.
 3. Hand trowel as required to provide surface.
 4. First troweling after power floating shall produce smooth surface relatively free of defects but which may still show some trowel marks.
 5. Second trowel by hand after surface has hardened.
 6. Leave finished surface essentially free of trowel marks, uniform in texture and appearance.
 7. On surfaces intended to support floor coverings, grind off defects that would show through floor covering.

- E. Broom or Belt Finish: Sweep surface with brushes, rakes, tines or burlap belt before final set. Finish concrete as specified for monolithic finish above, except omit final troweling and finish surface by drawing a coarse-hair broom across surface. Do all brooming in a direction indicated in the Drawings. If not indicated, brooming shall be parallel to expansion joints, or in cases of inclined slabs, perpendicular to slope.
- Finish concrete on face of platform edge by applying a hand rub finish after stripping form, then apply curing compound.
- F. "Dry Shake" Finish: Give the surface a floated finish. Evenly apply approximately 2/3 of a blended unsegregated material.
1. Begin floating immediately after application of first "dry shake".
 2. After material has been embedded by floating, apply remainder of blended material to surface at right angles to previous application.
 3. Make second application heavier in any areas not sufficiently covered by first application.
 4. Immediately follow with second floating.
 5. After selected material has been embedded by second floating, complete operation with a broomed, floated, or troweled finish, as indicated.
- G. Non-slip Finish: Give surface a "dry shake" application, using crushed ceramically bonded aluminum oxide particles. Apply at 25 pounds per 100 square feet.
- H. Seeded Exposed Aggregate Finish: Immediately after surface of concrete has been leveled to tolerance and surface water has dissipated, spread aggregate uniformly over surface to provide complete coverage to the depth of a single stone.
1. Embed aggregate into surface by light tamping.
 2. Float surface until embedded aggregate is fully coated with mortar and surface has been brought to tolerance.
 3. Start exposure of aggregate after matrix has hardened sufficiently to prevent dislodgment.
 4. Flow ample quantities of water, without force, over surface of concrete while matrix encasing aggregate is removed by brushing with a fine bristle brush.
 5. Continue until aggregate is uniformly exposed.
 6. An approved chemical retarder sprayed onto freshly floated surface may be used to extend working time.
- I. Sand Blast Finish:
1. Apply sandblasted finish to exposed concrete surfaces where indicated.
 2. Perform sandblasting at least 72 hours after placement of concrete. Coordinate with formwork construction, concrete placement schedule, and formwork removal to ensure that surfaces to be blast finish are blasted at the same age for uniform

results.

3. Determine type of nozzle, nozzle pressure, and blasting techniques required to match the approved mock-up.
 4. Abrasive-blast corners and edges of patterns carefully, using back-up boards, to maintain uniform corner or edge line.
 5. Depths of Cut: Use an abrasive grit of the proper type and gradation to expose aggregate and surrounding matrix surface to match approved mock-up.
 6. Generally expose coarse aggregate 3/16" to 1/4-inch reveal.
 7. Surface Continuity: Perform sand blast finishing in as continuous as operation as possible, utilizing the same work crew to maintain continuity of finish on each surface or area of work.
 8. Construction Joints shall be uniform and straight and terminate completely within an intersecting joint line.
 9. Protection and Repair: Protect adjacent materials and finishes from dust, dirt, and other surfaces or physical damage during abrasive-blast finishing operations. Provide protection as required and remove from site at completion of the work. Repair or replace other work damages by finishing operations.
 10. Clean-Up: Maintain control of concrete chips, dust and debris in each work area. Clean up and remove such material at the completion of each day of operation. Prevent migration of airborne materials by use of tarpaulins, wind breaks and similar containing devices.
- J. Non-Slip Finish: Provide non-slip finish in conformance with applicable codes.
- K. Course (Exposed) Aggregate Finishes: Standard gray with light water wash finish
- L. Exposed Aggregate Concrete Slab and Flatwork Finishing:
1. Do not use tools such as jitterbugs that force the aggregate away from top the surface
 2. Exposing Aggregate: Proceed as soon as the surface grout can be removed by simultaneous brushing and flushing with water without overexposing or dislodging the aggregate. Avoid traffic on the concrete during this operation. High pressure water may be used if desired finish is more easily achieved without harm to the concrete. Use same method of exposure, either with or without retarder, throughout the job.
 3. Top Surface Retarder:
 - i. Prepare small test panels to confirm the desired depth of the etch as approved by the Owner
 - ii. Protect surrounding areas from overspray application.
 - iii. Apply and remove pre manufacturer's instruction.
 - iv. In hot weather remove the retarded matrix in the same day.

3.3 FINISHING FORMED SURFACES

- A. General:
1. Allow concrete to cure not more than 72-hours before commencing surface finish operations, unless approved otherwise.
 2. Revise the finishes as needed to secure approval.
- B. As-Cast Form Finish:
1. Rough: Patch defects chip or rub off fins exceeding 1/4-inch height.
 2. Smooth: Patch tie holes and defects and remove fins completely.
 - a. When surface texture is impaired and form joints misaligned, grind, bush-hammer, or correct affected concrete.
 - b. Slurry grout areas evidencing minor mortar leakage to match adjacent concrete.
 - c. Repair major mortar leakage as a defective area.
 - d. When workmanship is less than acceptable standard, provide one of rubbed finishes. Standards must be acceptable to the company or by general consent as a basis of comparison.
 - e. Seat Wall: Corners shall be square with a 1/8" maximum radius
- C. Rubbed Finish:
1. Smooth Rubbed: Remove forms and perform necessary patching as soon after placement as possible.
 - a. Finish newly hardened concrete no later than 24-hours following form removal.
 - b. Wet surfaces and rub with carborundum brick or other abrasive until uniform color and texture are produced.
 2. Grout Cleaned: Undertake no cleaning operations until all contiguous surfaces are completed and accessible.
 - a. Wet surface of concrete sufficiently to prevent absorption of water from grout.
 - b. Apply grout uniformly.
 - c. Immediately after grouting, scrub surface with cork float or stone to coat surface and fill voids.
 - d. While grout is still plastic, remove excess grout by working surface with rubber float or sack.
 - e. After surface whitens from drying, rub vigorously with clean burlap.
 - f. Keep damp for at least 36-hours after final rubbing.

3. Cork Floated: Remove forms within 2 to 3 days of placement where possible.
 - a. Remove ties.
 - b. Remove all burrs and fins.
 - c. Dampen wall surface.
 - d. Apply mortar with firm rubber float or with trowel, filling all surface voids.
 - e. Compress mortar into voids.
 - f. If mortar surface dries too rapidly to permit proper compaction and finishing, apply a small amount of water with fog sprayer.
 - g. Produce final texture with cork float using a swirling motion.
- D. Unformed Finish:
 1. After concrete is placed, strike smooth, tops of walls or buttresses, horizontal offsets, and similar unformed surfaces occurring adjacent to formed surfaces.
 2. Float to texture that is reasonably consistent with formed surfaces.
 3. Continue final treatment on formed surfaces uniformly across unformed surfaces.
- E. Blasted Finish:
 1. Perform abrasive blasting within 24 to 72-hours after casting.
 2. Coordinate with form work construction, concrete placement schedule, and formwork removal to ensure that surfaces are blasted at the same age for uniform results.
 3. Reapply curing protection after blast finishing
- F. Architectural Finish: Refer to ACI 303.
 1. Tooled Finish:
 - a. Dress thoroughly cured concrete surface with electric, air, or hand tools to uniform texture, and give a bush hammered surface texture.
 - b. Remove sufficient mortar to exposed coarse aggregate in relief and to fracture coarse aggregate for tooled finish.
- G. Patched Finish:
 1. Repair defective areas.
 - a. Remove honeycomb and defective concrete to sound concrete.
 - b. Make edges perpendicular to surface or slightly undercut.
 - c. Feathered edges are not permitted.

- d. Dampen area to be patched and at least 6-inches surrounding it to prevent absorption of patching mortar water.
 - e. Prepare bonding grout.
 - f. Mix to consistency of thick cream.
 - g. Brush into surface.
2. Tie Holes: Unless indicated otherwise, after being cleaned and thoroughly dampened, fill tie hole solid with patching mortar.
 3. Make any patches in concrete to closely match color and texture of surrounding surfaces. Determine mix formula for patching mortar by trial and obtain a good color match with concrete when both patch and concrete are cured and dry.
 - a. Mix white and gray Portland cement as required to match surrounding concrete to produce grout having consistency of thick paint.
 - b. Use a minimum amount of mixing water.
 - c. Mix patching mortar in advance and allow to stand without frequent manipulation, without addition of water, until it has reached stiffest placeable consistency.
 - d. After initial set, dress surfaces of patches manually to obtain same texture as surrounding surfaces.
 4. After surface water has evaporated from patch area, brush bond coat into surface.
 - a. When bond coat begins to lose water sheen, apply patching mortar.
 - b. Thoroughly consolidate mortar into place and strike-off to leave patch slightly higher than surrounding surface.
 - c. Leave undisturbed for at least 1-hour before final finish.
 - d. Keep patched area damp for 72-hours or apply curing compound.
 - e. Do not use metal tools in finishing an exposed patch.
 5. Where as-cast finishes are indicated, total patched area may not exceed 1 in 500 of as-cast surface. This is in addition to form tie patches, if ties are permitted to fall within as-cast areas.
 6. In any finishing process which is intended to expose aggregate on surface, patched areas must show aggregate.
 - a. Outer 1-inch of patch shall contain same aggregates as surrounding concrete.
 - b. For aggregate transfer finish, patching mixture shall contain same selected colored aggregates.

- c. After curing, expose aggregates together with aggregates of adjoining surfaces by same process.

PART IV - MEASUREMENT

- 4.1 **Measurement** – No Separate measurement will be made for Work described in this Section.

PART V - PAYMENT

- 5.1 **Payment** – Payment for items in this Section will be incidental to the Contract unit cost of the concrete bid items

END OF SECTION

SECTION 03 35 43**HONED AND POLISHED CONCRETE FINISHING****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. This Section includes finishing cast-in-place architectural concrete surfaces by honing, applying liquid treatment, and polishing. Applications include the following:
 - 1. Slabs-on-grade as identified on Drawings.
- B. Related Sections include the following:
 - 1. Division 03 Section "Cast-In-Place Concrete" for finishing and curing requirements.
 - 2. Division 03 Section "Concrete Floor Curing, Sealing, And Dustproofing."
 - 3. Division 03 Section "Concrete Floor Sealing And Hardening."
 - 4. Division 07 Section "Joint Sealants" for elastomeric joint sealants in contraction and other joints in cast-in-place concrete slabs.

1.03 SUBMITTALS

- A. Product Data: For each type of product indicated. Include manufacturer's technical data, application instructions, and recommendations for each liquid floor treatment component required.
- B. Qualification Data: For Installer.
- C. Installer Certificates: Signed by manufacturer certifying that installers comply with specified requirements.
- D. Material Test Reports: For liquid floor treatment, from a qualified testing agency, indicating compliance with system physical properties specified.
- E. Minutes of preinstallation conference.

1.04 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an experienced installer (applicator) who is experienced in applying liquid floor treatments similar in material, design, and extent to those indicated for this Project, whose work has resulted in applications with a record of successful in-service performance, and who is acceptable to liquid floor treatment manufacturer.
 - 1. Engage an installer who employs only persons trained and approved by liquid floor treatment manufacturer for applying liquid floor treatment systems indicated.
 - 2. Engage an installer who is certified in writing by liquid floor treatment manufacturer as qualified to apply liquid floor treatment systems indicated.
- B. Source Limitations: Obtain primary liquid floor treatment materials through one

source from a single manufacturer. Provide secondary materials, including honing and polishing material of type and from source recommended by manufacturer of primary materials.

- C. Field Sample Panels: Before casting concrete slab, produce field sample panels to demonstrate typical joints, surface finish, texture, tolerances, and standard of workmanship of specified finish. Produce a minimum of 3 sets of full-scale panels, cast horizontally, approximately 48 by 48 by 4 inches minimum, to demonstrate the expected range of finish, color, and texture variations.
1. Locate panels as indicated or, if not indicated, as directed by Architect.
 2. Demonstrate methods of finishing concrete, curing, cleaning, protecting, honing, applying liquid treatment, and polishing, as applicable. Include contraction joint in panel.
 3. In presence of Architect, damage part of an exposed-face surface for each finish, color, and texture, and demonstrate materials and techniques proposed for repair of surface blemishes to match adjacent undamaged surfaces.
 4. Maintain field sample panels as approved by Architect during construction in an undisturbed condition as a standard for judging the completed Work.
 5. Demolish and remove field sample panels when directed.
- D. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management And Coordination."
1. Require representatives of each entity directly concerned with cast-in-place concrete installation and concrete finishing work to attend.
 2. Review concrete finishes and finishing, concrete repair procedures, and concrete protection of cast-in-place concrete floor surfaces.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in original packages and containers, with seals unbroken, bearing manufacturer's labels indicating brand name and directions for storage and mixing with other components.
- B. Store materials to prevent deterioration from moisture, heat, cold, direct sunlight, or other detrimental effects.

1.06 PROJECT CONDITIONS

- A. Prior to honing, liquid treatment, and polishing operations comply with following:
1. Concrete shall have cured a minimum of 45 days.
 2. Protect concrete surfaces from staining by operations, materials, and products including the following:
 - a. Petroleum products including hydraulic fluids, oil, metal cutting lubricants, and waxes.
 - b. Rust and similar staining caused by corroding metal.
 - c. Acids and acidic detergents.
 3. Defer application of sealants to contraction and isolation joints until after work of this Section is complete.
- B. Environmental Limitations: Comply with liquid floor treatment manufacturer's written instructions for substrate temperature, ambient temperature, moisture, ventilation, and other conditions affecting liquid floor treatment application.

- C. Lighting: Provide permanent lighting or, if permanent lighting is not in place, simulate permanent lighting conditions during honing, sealer, and polishing operations.
- D. Close spaces to traffic during honing, sealer, and polishing operations and for not less than 24 hours after polishing, unless manufacturer recommends a longer period.

1.07 SEQUENCING

- A. Trowel Finish: Floors receiving honed, sealed and polished finish shall be trowel finished in accordance with Division 03 Section "Cast-In-Place Concrete."

PART 2 - PRODUCTS

2.01 FLOOR AND SLAB TREATMENTS

- A. Penetrating Liquid Floor Treatment: Clear, chemically reactive, waterborne solution of inorganic silicate or silicate materials and proprietary components; odorless; colorless; that penetrates, hardens, and densifies concrete surfaces.
 - 1. Product: Subject to compliance with the requirements provide Advance Floor Products; Retro-Plate 99.
- B. Sheen: Satin finish.
- C. System Physical Properties: Provide liquid floor treatment system with the following comparative physical property requirements when tested according to test methods indicated:
 - 1. Abrasion Resistance: Up to 400 percent increase per ASTM C 779.
 - 2. Impact Strength: Up to 21 percent increase per ASTM C 805.
 - 3. UV and Water Spray: No adverse effect per ASTM G 23-81.
 - 4. Reflectivity: Up to 30 percent increase.

2.02 ACCESSORY MATERIALS

- A. Neutralizing Agent: Tri-sodium phosphate (TSP).
- B. Water: Potable.

PART 3 - EXECUTION

3.01 PREPARATION

- A. General: Prepare and clean substrates according to liquid floor treatment manufacturer's written instructions for substrate indicated. Provide clean, dry, and neutral pH substrate for liquid floor treatment application.
- B. Concrete Substrates: Provide sound concrete surfaces free of laitance, glaze, efflorescence, curing compounds, form-release agents, dust, dirt, grease, oil, and other contaminants incompatible with liquid floor treatment flooring.
 - 1. Repair damaged and deteriorated concrete according to liquid floor treatment manufacturer's written recommendations.
 - a. Use patching and fill material to fill holes and depressions in substrates according to liquid floor treatment manufacturer's written instructions.

2. Hone concrete substrates using concrete honing equipment approved by liquid floor treatment manufacturer to produce sheen specified in Part 2 above and to match approved Field Sample Panel.

- C. Liquid Floor Treatment Materials: Mix components and prepare materials according to liquid floor treatment manufacturer's written instructions.

3.02 LIQUID FLOOR TREATMENT APPLICATION

- A. Uniformly apply liquid floor treatment according to manufacturer's written instructions.
 1. Do not apply to concrete that is less than 45 days' old.
 2. Cure liquid floor treatment according to manufacturer's written instructions. Prevent contamination during application and curing processes.

3.03 POLISHING

- A. Polish treated, cured concrete surface using polishing equipment approved by liquid floor treatment manufacturer to produce surface sheen specified in Part 2 above and to match approved Field Sample Panel to satisfaction of Architect.
 1. Maintain uniformity of sheen over contraction, expansion, and construction joints, unless otherwise indicated.

3.04 REPAIRS, PROTECTION, AND CLEANING

- A. Repair and cure damaged finished surfaces of polished concrete when approved by Architect. Match repairs to color, texture, and uniformity of surrounding surfaces and to repairs on approved Field Sample Panel.
 1. Remove and replace polished concrete that cannot be repaired and cured to Architect's approval.
- B. Protect corners, edges, and surfaces of polished concrete from damage; use guards and barricades.
- C. Protect polished concrete from staining, laitance, and contamination during remainder of construction period.
- D. Clean polished concrete surfaces after finish treatment to remove stains, markings, dust, and debris.
- E. Wash and rinse polished surfaces according to liquid treatment manufacturer's written recommendations. Protect other Work from staining or damage due to cleaning operations.
 1. Do not use cleaning materials or processes that could change the appearance of polished concrete finishes.

END OF SECTION 03 35 43

SECTION 03 39 00
CONCRETE CURING**PART I - GENERAL****1.1 SUMMARY**

- A. Description: The work in this Section includes furnishing curing materials and applying the curing materials to fresh green concrete for structural members as stipulated in the Contract Drawings. The work shall include furnishing labor, material, tools, and equipment as necessary to complete the work described herein.

1.2 REFERENCES

<u>Sponsor</u>	<u>Number</u>	<u>Subject</u>
AASHTO	M148	Liquid Membrane-Forming Compounds for Curing Concrete
ASTM	C156	Water Retention by Concrete Curing Materials
ASTM	C309	Liquid Membrane-Forming Compounds for Curing Concrete
ASTM	D3960	Determining Volatile Organic Compound (VOC) Content of Paints and Related Coatings
ASTM	E1347	Color and Color-Difference Measurement by Tristimulus (Filter) Colorimeter

1.3 SUBMITTALS

- A. Submittals shall be made in accordance with the requirements of the Project Quality Plan, except as modified herein.
- B. Concrete Curing Compound.
- C. Manufacturer's certificate of compliance.
- D. Product data sheet, instructions, limitations, and track records.
- E. Test results showing no component deleterious to concrete quality.
- F. Steam curing system description.
- G. Materials and curing methods shall be pre-approved by the Engineer 90 calendar days after commencement of the project, or at least 30 calendar days before the commencement of any concrete work.

1.4 QUALITY CONTROL

- A. Quality control shall be made in accordance with the requirements of the Project Quality Plan, except as modified herein.

- B. Use curing compounds that have been successfully applied in projects of similar type and magnitude, in location of similar project conditions.
- C. Curing compounds shall not de-color concrete surfaces after application.

PART II - PRODUCTS

2.1 CURING COMPOUND FOR STRUCTURAL AND ARCHITECTURAL CONCRETE

- A. Compound materials shall comply with AASHTO M 148, Type 1.D, Class A requirements.

2.2 CURING COMPOUND FOR PORTLAND CEMENT CONCRETE PAVEMENT

- A. Compound materials shall be resin type poly-alpha-methylstyrene (PAMS), conforming to ASHTO M 148, Type 2, Class B and the criteria in Table 1.
- B. Compound shall not exhibit significant phase separation for a 24-hour period following thorough agitation.

Table 1

Characteristics (Curing compound for PCC)	Min.	Max.	ASTM
Total Solids, percent by weight compound	35		
TiO ₂ Pigment, percent reflectance	60		E 1347
Drying Time: Set to touch, min. Track Free, min		60 120	C 309
Coverage rate, gallon/ft ²		0.01	
Water Loss, lb/ft ² in 72 hours	7.8		C 156
Flash point, degrees F		660	
V.O.C. Content, g/L <small>N.W.</small>			D 3960

2.3 CURING COMPOUND FOR LEAN CONCRETE BASE COURSE

- A. Compound materials shall be wax base and conform to AASHTO M 148, Type 2.

2.4 CURING COMPOUND FOR CONCRETE BARRIER

- A. Meet AASHTO M 148, Type 1-D, Class B.

PART III - EXECUTION

3.1 PREPARATION

- A. Verify concrete surfaces are ready for curing. Correct conditions detrimental to timely and proper completion of the work. Do not proceed until unsatisfactory conditions are corrected.

- B. Follow product manufacturer's recommendations for preparing surfaces.
- C. For newly placed concrete using membrane-curing compound method:
 - 1. Deliver the curing compound in a ready-mixed form with the pigment uniformly disbursed without diluting or altering the compound. If the compound is chilled and too viscous, warm it to a maximum of 100 degree F.
 - 2. Keep surfaces moist until the curing compound is applied.
 - 3. Complete all patching or surface finishing before applying compound.
- D. For lean concrete base course curing: do not dilute or alter the compound.

3.2 CURING PRESTRESSED CONCRETE

- A. Cure following this Section, article 3.8, Curing Structures or article 3.7, Steam Curing, until concrete has reached a strength of 4,000 psi or as designated on the plans.

3.3 CURING PRE-CAST CONCRETE BARRIER

- A. Cure exposed surfaces immediately after finishing operations are completed. Apply the curing compound in conformance with manufacturer's specifications.
- B. Steam curing may be used for pre-cast barrier.
- C. After removing form, broom clean the surface of the barrier and apply two coats of curing compound in accordance with manufacturer's specifications.

3.4 CURING CAST-IN-PLACE CONCRETE BARRIER

- A. Cure immediately after finishing operations are completed.
- B. Apply two coats of curing compound as specified in 3.3.C.

3.5 CURING LEAN CONCRETE BASE COURSE

- A. After finishing operations are complete, apply curing compound.
 - 1. Spray entire exposed area (top and sides) at a rate specified by manufacturer.
 - 2. Use fully atomizing mechanical sprayers that have a wind-protective hood.
 - 3. Hand spray on small areas and areas inaccessible to mechanical spraying equipment.
 - 4. Provide complete coverage with curing compound at edges, corners, sides, and rough spots.
- B. Damage to the film of curing compound occurring within 72 hours of application must be repaired immediately.

3.6 CURING PORTLAND CEMENT CONCRETE PAVEMENT

- A. Pretest the liquid membrane curing compound using an infrared spectrometer to determine specification compliance.
- B. Delay placing concrete pavement until an acceptable shipment of curing compound is received.
- C. Warm viscous curing-sealing compound to a temperature not to exceed 100 degree F if necessary.
- D. Thoroughly mix the compound during use and uniformly disperse the pigment throughout the vehicle. Stir continuously mechanically during application and do not dilute or alter in any manner.
- E. Apply compound to the entire pavement surface and exposed edges immediately after completing finishing operations in accordance with manufacturers specifications.
 - 1. Apply the curing compound in two approximately equal applications.
 - 2. Apply the second application in the opposite longitudinal direction as the first.
 - 3. Allow at least 30 minutes between applications.
 - 4. Small and irregular areas and areas inaccessible to mechanical spraying equipment may be hand sprayed.
- F. Stop paving operations if the application of the compound behind the paving machine is delayed until the problem is resolved.
 - 1. Keep the pavement moist with water until the compound application process is resumed.
 - 2. Apply the water in a fog-mist spray without damaging the pavement surface texture.
- G. Immediately repair any damage to the compound film occurring until seven days after the initial application.

3.7 STEAM CURING

- A. Provide a complete steam curing system approved by the Engineer including 24 hour temperature control and monitoring devices, and a suitable enclosure to contain live steam and minimize moisture and heat losses.
- B. Do not apply steam until the concrete has set. Wait 4 to 6 hours if retarders are used. If no retarders are used, wait 2 to 4 hours.
- C. Maintain 100 percent relative humidity in the steam curing enclosure.
- D. Do not apply steam directly on the concrete.
- E. When applying steam, increase the ambient air temperature at a rate not to exceed 40 degree F per hour until a temperature range of 140 degree to 160 degree F is reached.
- F. Maintain the temperature range until the concrete has reached the specified strength.

- G. When discontinuing the steam, decrease the ambient air temperature at a rate not to exceed a 40 degree F per hour until reaching a temperature of not more than 20 degree F above the air temperature to which the concrete will be exposed.

3.8 CURING STRUCTURES

- A. Cure bridge decks, approach slabs, curbs, and parapets.
1. Apply an application of membrane-curing compound to concrete bridge decks and approach slabs. Apply the compound so that no portion of the deck or approach slab is exposed to the drying effects of the atmosphere for more than 20 minutes after the timing operation. Have a work bridge follow immediately after the finishing machine to allow application of the curing compound while the concrete is still plastic.
 2. Cover bridge decks, approach slabs, curbs, and parapet walls with cotton or burlap mats, or wet curing blankets (meeting AASHTO M171), without damaging the finish, as soon as the concrete is sufficiently set to support the materials.
 3. Keep concrete moist continuously for 7 days after placement.
 4. Use material that retains moisture such as burlap mats.
 5. Wet curing blanket prior to placing it on the concrete surface.
 6. Keep the entire surface damp through the use of soaker hoses, but do not wash away or erode the surface.
 7. Restrain the cotton or burlap mats, or wet curing blankets, without damaging the surface, to prevent them from blowing off due to the wind or other forces.
- B. Use membrane-curing compound method to cure all other newly placed concrete.
1. Keep surfaces wet and moist until the curing compound is applied.
 2. Complete all patching or surface finishing before applying compound.
 3. Uniformly spray the entire surface of the concrete with membrane curing compound.
 4. Immediately re-spray any portion damaged before the 7-day curing expires.
 5. Deliver the curing compound in a ready-mixed form with the pigment uniformly dispersed without diluting or altering the compound.
 6. Warm chilled compound that it is too viscous to a maximum of 100° F.
 7. Apply the compound at a uniform rate as specified by the manufacturer. If the application is delayed, immediately apply water as provided in this section and continue until application is resumed.

PART IV - MEASUREMENT

4.1 Measurement – No Separate measurement will be made for Work described in this Section.

PART V - PAYMENT

5.1 Payment – Payment for items in this Section will be incidental to the Contract unit cost of the concrete bid items.

END OF SECTION

SECTION 03 45 00**PRECAST ARCHITECTURAL CONCRETE****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY**A. Section Includes:**

- 1. Architectural precast concrete cladding units.
- 2. Insulated, architectural precast concrete units.

B. Related Requirements:

- 1. Section 03 30 00 "Cast-in-Place Concrete" for installing connection anchors in concrete.
- 2. Section 05 12 00 "Structural Steel Framing" for furnishing and installing connections attached to structural-steel framing.
- 3. Section 05 50 10 "Miscellaneous Metal Fabrications" for kickers and other miscellaneous steel shapes.
- 4. Division 08 windows sections for windows set into architectural precast concrete units.

1.03 DEFINITIONS

- A. Design Reference Sample: Sample of approved architectural precast concrete color, finish and texture, preapproved by Architect.

1.04 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.05 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Design Mixtures: For each precast concrete mixture. Include compressive strength and water-absorption tests.
- C. Shop Drawings:
 - 1. Detail fabrication and installation of architectural precast concrete units.
 - 2. Indicate locations, plans, elevations, dimensions, shapes, and cross sections of each unit.
 - 3. Indicate joints, reveals, drips, chamfers, and extent and location of each surface finish.
 - 4. Indicate details at building corners.
 - 5. Indicate separate face and backup mixture locations and thicknesses.
 - 6. Indicate type, size, and length of welded connections by AWS standard symbols. Detail loose and cast-in hardware and connections.

7. Indicate locations, tolerances, and details of anchorage devices to be embedded in or attached to structure or other construction.
 8. Indicate locations, extent, and treatment of dry joints if two-stage casting is proposed.
 9. Include plans and elevations showing unit location and sequence of erection for special conditions.
 10. Indicate location of each architectural precast concrete unit by same identification mark placed on panel.
 11. Indicate relationship of architectural precast concrete units to adjacent materials.
 12. If design modifications are proposed to meet performance requirements and field conditions, submit design calculations and Shop Drawings. Do not adversely affect the appearance, durability, or strength of units when modifying details or materials and maintain the general design concept.
- D. Samples: Design reference samples for initial verification of design intent, for each type of finish indicated on exposed surfaces of architectural precast concrete units, in sets of three, representative of finish, color, and texture variations expected; approximately 12 by 12 by 2 inches. Match Architect's sample.
1. When other faces of precast concrete unit are exposed, include Samples illustrating workmanship, color, and texture of backup concrete as well as facing concrete.
- E. Delegated-Design Submittal: For architectural precast concrete indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
1. Show governing panel types, connections, types of reinforcement, including special reinforcement, and concrete cover on reinforcement. Indicate location, type, magnitude, and direction of loads imposed on the building structural frame from architectural precast concrete.

1.06 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer, fabricator, and testing agency.
- B. Welding certificates.
- C. Material Certificates: For the following items:
 1. Cementitious materials.
 2. Reinforcing materials and prestressing tendons.
 3. Admixtures.
 4. Bearing pads.
 5. Structural-steel shapes and hollow structural sections.
 6. Insulation.
- D. Material Test Reports: For aggregates.
- E. Preconstruction test reports.
- F. Source quality-control test reports.
- G. Field quality-control and special inspection reports.

1.07 QUALITY ASSURANCE

- A. Installer Qualifications: A precast concrete erector who has retained a "PCI-Certified

Field Auditor" to conduct a field audit of a project in same category as this Project and who can produce an Erectors' Post-Audit Declaration.

- B. Fabricator Qualifications: A firm that assumes responsibility for engineering architectural precast concrete units to comply with performance requirements. This responsibility includes preparation of Shop Drawings and comprehensive engineering analysis by a qualified professional engineer.
 - 1. Designated as a PCI-certified plant for Group A, Category A1 - Architectural Cladding and Load Bearing Units or designated as an APA-certified plant for production of architectural precast concrete products.
 - 2. Fabricator is located within 500 miles of Project site.
- C. Testing Agency Qualifications: An independent testing agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.
- D. Quality-Control Standard: For manufacturing procedures and testing requirements, quality-control recommendations, and dimensional tolerances for types of units required, comply with PCI MNL 117, "Manual for Quality Control for Plants and Production of Architectural Precast Concrete Products."
- E. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D.1.1M, "Structural Welding Code - Steel"; and AWS D1.4/D.1.4M, "Structural Welding Code - Reinforcing Steel."
- F. Sample Panels: After sample approval and before fabricating architectural precast concrete units, produce a minimum of two sample panels approximately 16 sq. ft. in area for review by Architect. Incorporate full-scale details of architectural features, finishes, textures, and transitions in sample panels.
 - 1. Locate panels where indicated or, if not indicated, as directed by Architect.
 - 2. Damage part of an exposed-face surface for each finish, color, and texture, and demonstrate adequacy of repair techniques proposed for repair of surface blemishes.
 - 3. After acceptance of repair technique, maintain one sample panel at manufacturer's plant and one at Project site in an undisturbed condition as a standard for judging the completed Work.
 - 4. Demolish and remove sample panels when directed.
- G. Range Samples: After sample panel approval and before fabricating architectural precast concrete units, produce a minimum of three sets of samples, approximately 16 sq. ft. in area, representing anticipated range of each color and texture on Project's units. Maintain one set of range samples at Project site and remaining range sample sets at manufacturer's plant as color and texture approval reference.
- H. Mockups: After range sample approval but before production of architectural precast concrete units, construct full-sized mockups to verify selections made under range sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
 - 1. Build mockup as indicated on Drawings including aluminum framing, glass, sealants, and architectural precast concrete complete with anchors, connections, flashings, and joint fillers.
 - 2. Damage part of an exposed-face surface for each finish, color, and texture, and demonstrate adequacy of repair techniques proposed for repair of surface blemishes.
 - 3. After acceptance of repair technique, maintain mockup at Project site in an

- undisturbed condition as a standard for judging the completed Work.
4. Demolish and remove mockup when directed.

- I. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management And Coordination."

1.08 COORDINATION

- A. Furnish loose connection hardware and anchorage items to be embedded in or attached to other construction without delaying the Work. Provide locations, setting diagrams, templates, instructions, and directions, as required, for installation.

1.09 DELIVERY, STORAGE, AND HANDLING

- A. Deliver architectural precast concrete units in such quantities and at such times to limit unloading units temporarily on the ground or other rehandling.
- B. Support units during shipment on nonstaining shock-absorbing material.
- C. Store units with adequate dunnage and bracing and protect units to prevent contact with soil, to prevent staining, and to prevent cracking, distortion, warping or other physical damage.
- D. Place stored units so identification marks are clearly visible, and units can be inspected.
- E. Handle and transport units in a manner that avoids excessive stresses that cause cracking or damage.
- F. Lift and support units only at designated points indicated on Shop Drawings.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Fabricators: Subject to compliance with requirements, available fabricators offering products that may be incorporated into the Work include, but are not limited to, the following:
 1. Stresscon Corporation.
 2. Rocky Mountain Prestress, Inc.

2.02 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design architectural precast concrete units.
- B. Design Standards: Comply with [ACI 318](#) and design recommendations of PCI MNL 120, "PCI Design Handbook - Precast and Prestressed Concrete," applicable to types of architectural precast concrete units indicated.
- C. Calculated Fire-Test-Response Characteristics: Provide architectural precast concrete units with fire-resistance rating indicated as calculated according to [ACI 216.1](#) and acceptable to authorities having jurisdiction.
- D. Structural Performance: Provide architectural precast concrete units and connections

capable of withstanding the following design loads within limits and under conditions indicated:

1. Loads: As indicated.
2. Thermal Movements: Provide for in-plane thermal movements resulting from annual ambient temperature changes of 120 deg F.
3. Fire-Resistance Rating: Select material and minimum thicknesses to provide 1-hour fire rating.

2.03 MOLD MATERIALS

- A. Molds: Rigid, dimensionally stable, non-absorptive material, warp and buckle free, that provides continuous and true precast concrete surfaces within fabrication tolerances indicated; nonreactive with concrete and suitable for producing required finishes.
 1. Mold-Release Agent: Commercially produced form-release agent that does not bond with, stain or adversely affect precast concrete surfaces and does not impair subsequent surface or joint treatments of precast concrete.
- B. Surface Retarder: Chemical set retarder, capable of temporarily delaying final hardening of newly placed concrete mixture to depth of reveal specified.

2.04 REINFORCING MATERIALS

- A. Refer to Division 03 concrete sections for requirements for reinforcing materials.

2.05 PRESTRESSING TENDONS

- A. Prestressing Strand: ASTM A 416/A 416M, Grade 270, uncoated, seven-wire, low-relaxation strand.
 1. Coat unbonded post-tensioning strand with post-tensioning coating complying with ACI 423.7 and sheath with polypropylene tendon sheathing complying with ACI 423.7. Include anchorage devices and coupler assemblies.

2.06 CONCRETE MATERIALS

- A. Regional Materials: Precast architectural concrete shall be manufactured from aggregates and cement that have been extracted or recovered, as well as manufactured, within 500 miles of Project site.
- B. Portland Cement: ASTM C 150/C 150M, Type I or Type III, gray, unless otherwise indicated.
 1. For surfaces exposed to view in finished structure, use white cement, 680, of same type, brand, and mill source.
- C. Supplementary Cementitious Materials:
 1. Fly Ash: ASTM C 618, Class C or F, with maximum loss on ignition of 3 percent.
 2. Metakaolin: ASTM C 618, Class N.
 3. Silica Fume: ASTM C 1240, with optional chemical and physical requirement.
 4. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.
- D. Normal-Weight Aggregates: Except as modified by PCI MNL 117, ASTM C 33/C 33M, with coarse aggregates complying with Class 5S. Stockpile fine and coarse aggregates for each type of exposed finish from a single source (pit or quarry) for

Project.

1. Face-Mixture-Fine Aggregates: Selected, natural or manufactured sand compatible with coarse aggregate; to match approved finish sample.
- E. Lightweight Aggregates: Except as modified by PCI MNL 117, ASTM C 330/C 330M, with absorption less than 11 percent.
- F. Coloring Admixture: ASTM C 979/C 979M, synthetic or natural mineral-oxide pigments or colored water-reducing admixtures, temperature stable, and nonfading.
- G. Basis of Design Mix Designs: Following mix designs based on design reference sample.

Light Gray Panels		Cubic Yard Amounts
Cement Color	White	680.00 lbs.
Color Admixture	DCS #2703 Black (0.40%)	2.72 lbs.
Coarse Aggregate	Canyon Gray (Salida) 1/4" x 1/2"	1700.00 lbs.
Sand	Light Gray Sand	1250.00 lbs.
Admixtures	As required	
Air Entrainment	5 percent	
Water/Cement Ratio	0.42	
Finish	Flat Acid-Etched (1-4)	

- H. Water: Potable; free from deleterious material that may affect color stability, setting, or strength of concrete and complying with chemical limits of PCI MNL 117.
- I. Air-Entraining Admixture: ASTM C 260, certified by manufacturer to be compatible with other required admixtures.
- J. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures and to not contain calcium chloride, or more than 0.15 percent chloride ions or other salts by weight of admixture.
 1. Water-Reducing Admixtures: ASTM C 494/C 494M, Type A.
 2. Retarding Admixture: ASTM C 494/C 494M, Type B.
 3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
 4. Water-Reducing and Accelerating Admixture: ASTM C 494/C 494M, Type E.
 5. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
 6. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
 7. Plasticizing Admixture: ASTM C 1017/C 1017M, Type I.
 8. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.
 9. Corrosion Inhibiting Admixture: ASTM C 1582/C 1582M.

2.07 STEEL CONNECTION MATERIALS

- A. Carbon-Steel Shapes and Plates: ASTM A 36/A 36M.
- B. Carbon-Steel-Headed Studs: ASTM A 108, AISI 1018 through AISI 1020, cold finished, AWS D1.1/D1.1M, Type A or Type B, with arc shields and with minimum mechanical properties of PCI MNL 117, Table 3.2.3.
- C. Carbon-Steel Plate: ASTM A 283/A 283M, Grade C.
- D. Malleable Iron Castings: ASTM A 47/A 47M, Grade 32510 or Grade 35028.

- E. Carbon-Steel Castings: ASTM A 27/A 27M, Grade 60-30.
- F. High-Strength, Low-Alloy Structural Steel: ASTM A 572/A 572M.
- G. Carbon-Steel Structural Tubing: ASTM A 500/A 500M, Grade B or Grade C.
- H. Wrought Carbon-Steel Bars: ASTM A 675/A 675M, Grade 65.
- I. Deformed-Steel Wire or Bar Anchors: ASTM A 496/A 496M or ASTM A 706/A 706M.
- J. Carbon-Steel Bolts and Studs: ASTM A 307, Grade A or ASTM F 1554, Grade 36; carbon-steel, hex-head bolts and studs; carbon-steel nuts, ASTM A 563; and flat, unhardened steel washers, ASTM F 844.
- K. High-Strength Bolts and Nuts: ASTM A 325, Type 1, heavy hex steel structural bolts; heavy hex carbon-steel nuts, ASTM A 563; and hardened carbon-steel washers, ASTM F 436.
- L. Zinc-Coated Finish: For exterior steel items, steel in exterior walls, and items indicated for galvanizing, apply zinc coating by hot-dip process according to ASTM A 123/A 123M or ASTM A 153/A 153M.
 - 1. For steel shapes, plates, and tubing to be galvanized, limit silicon content of steel to less than 0.03 percent or to between 0.15 and 0.25 percent or limit sum of silicon and 2.5 times phosphorous content to 0.09 percent.
 - 2. Galvanizing Repair Paint: High-zinc-dust-content paint with dry film containing not less than 94 percent zinc dust by weight, and complying with DOD-P-21035B or SSPC-Paint 20.
- M. Welding Electrodes: Comply with AWS standards.

2.08 BEARING PADS

- A. Provide one of the following bearing pads for architectural precast concrete units as recommended by precast fabricator for application:
 - 1. Elastomeric Pads: AASHTO M 251, plain, vulcanized, 100 percent polychloroprene (neoprene) elastomer, molded to size or cut from a molded sheet, Type A durometer hardness of 50 to 70, ASTM D 2240, minimum tensile strength 2250 psi, ASTM D 412.
 - 2. Random-Oriented-Fiber-Reinforced Elastomeric Pads: Preformed, randomly oriented synthetic fibers set in elastomer. Type A durometer hardness of 70 to 90, ASTM D 2240; capable of supporting a compressive stress of 3000 psi with no cracking, splitting, or delaminating in the internal portions of pad. Test one specimen for every 200 pads used in Project.
 - 3. Cotton-Duck-Fabric-Reinforced Elastomeric Pads: Preformed, horizontally layered cotton-duck fabric bonded to an elastomer; Type A durometer hardness of 80 to 100, ASTM D 2240; complying with AASHTO's "AASHTO LRFD Bridge Design Specifications," Division II, Section 18.10.2; or with MIL-C-882E.
 - 4. Frictionless Pads: PTFE, glass-fiber reinforced, bonded to stainless or mild-steel plate, or random-oriented-fiber-reinforced elastomeric pads; of type required for in-service stress.
 - 5. High-Density Plastic: Multimonomer, nonleaching, plastic strip.

2.09 ACCESSORIES

- A. Reglets: Stainless steel, Type 302 or Type 304, felt or fiber filled, or with face opening

of slots covered.

- B. Precast Accessories: Provide clips, hangers, high-density plastic or steel shims, and other accessories required to install architectural precast concrete units.

2.10 GROUT MATERIALS

- A. Sand-Cement Grout: Portland cement, ASTM C 150/C 150M, Type I, and clean, natural sand, ASTM C 144 or ASTM C 404. Mix at ratio of 1 part cement to 2-1/2 to 3 parts sand, by volume, with minimum water required for placement and hydration. Water-soluble chloride ion content less than 0.06 percent by weight of cement when tested according to ASTM C 1218/C 1218M.
- B. Nonmetallic, Nonshrink Grout: Packaged, nonmetallic, noncorrosive, nonstaining grout containing selected silica sands, portland cement, shrinkage-compensating agents, plasticizing and water-reducing agents, complying with ASTM C 1107/C 1107M, Grade A for drypack and Grades B and C for flowable grout and of consistency suitable for application within a 30-minute working time. Water-soluble chloride ion content less than 0.06 percent by weight of cement when tested according to ASTM C 1218/C 1218M.
- C. Epoxy-Resin Grout: Two-component, mineral-filled epoxy resin; ASTM C 881/C 881M, of type, grade, and class to suit requirements.

2.11 CONCRETE MIXTURES

- A. Prepare design mixtures for each type of precast concrete required.
 - 1. Use a single design mixture for units with more than one major face or edge exposed.
 - 2. Where only one face of unit is exposed use either a single design mixture or separate mixtures for face and backup.
- B. Limit use of fly ash and ground granulated blast-furnace slag to 20 percent of portland cement by weight; limit metakaolin and silica fume to 10 percent of portland cement by weight.
- C. Design mixtures may be prepared by a qualified independent testing agency or by qualified precast plant personnel at architectural precast concrete fabricator's option.
- D. Limit water-soluble chloride ions to maximum percentage by weight of cement permitted by [ACI 318](#) or [PCI MNL 117](#) when tested according to ASTM C 1218/C 1218M.
- E. Normal-Weight Concrete Mixtures: Proportion face and backup mixtures or full-depth mixtures, at fabricator's option by either laboratory trial batch or field test data methods according to [ACI 211.1](#), with materials to be used on Project, to provide normal-weight concrete with the following properties:
 - 1. Compressive Strength (28 Days): [5000 psi](#) minimum.
 - 2. Maximum Water-Cementitious Materials Ratio: [0.45](#).
- F. Water Absorption: 6 percent by weight or 14 percent by volume, tested according to ASTM C 642, except for boiling requirement.
- G. Lightweight Concrete Backup Mixtures: Proportion mixtures by either laboratory trial batch or field test data methods according to [ACI 211.2](#), with materials to be used on Project, to provide lightweight concrete with the following properties:

1. Compressive Strength (28 Days): 5000 psi.
 2. Unit Weight: Calculated equilibrium unit weight of 115 lb/cu. ft., plus or minus 3 lb/cu. ft., according to ASTM C 567.
- H. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having an air content complying with PCI MNL 117.
- I. When included in design mixtures, add other admixtures to concrete mixtures according to manufacturer's written instructions.

2.12 MOLD FABRICATION

- A. Molds: Accurately construct molds, mortar tight, of sufficient strength to withstand pressures due to concrete-placement operations and temperature changes and for prestressing and detensioning operations. Coat contact surfaces of molds with release agent before reinforcement is placed. Avoid contamination of reinforcement and prestressing tendons by release agent.
- B. Maintain molds to provide completed architectural precast concrete units of shapes, lines, and dimensions indicated, within fabrication tolerances specified.
1. Form joints are not permitted on faces exposed to view in the finished work.
 2. Edge and Corner Treatment: Uniformly chamfered.

2.13 FABRICATION

- A. Cast-in Anchors, Inserts, Plates, Angles, and Other Anchorage Hardware: Fabricate anchorage hardware with sufficient anchorage and embedment to comply with design requirements. Accurately position for attachment of loose hardware, and secure in place during precasting operations. Locate anchorage hardware where it does not affect position of main reinforcement or concrete placement.
1. Weld-headed studs and deformed bar anchors used for anchorage according to AWS D1.1/D1.1M and AWS C5.4, "Recommended Practices for Stud Welding."
- B. Furnish loose hardware items including steel plates, clip angles, seat angles, anchors, dowels, cramps, hangers, and other hardware shapes for securing architectural precast concrete units to supporting and adjacent construction.
- C. Cast-in reglets, slots, holes, and other accessories in architectural precast concrete units as indicated on the Contract Drawings.
- D. Cast-in openings larger than 10 inches in any dimension. Do not drill or cut openings or prestressing strand without Architect's approval.
- E. Reinforcement: Comply with recommendations in PCI MNL 117 for fabricating, placing, and supporting reinforcement.
1. Clean reinforcement of loose rust and mill scale, earth, and other materials that reduce or destroy the bond with concrete. When damage to epoxy-coated reinforcing exceeds limits specified in ASTM A 775/A 775M, repair with patching material compatible with coating material and epoxy coat bar ends after cutting.
 2. Accurately position, support, and secure reinforcement against displacement during concrete-placement and consolidation operations. Completely conceal support devices to prevent exposure on finished surfaces.
 3. Place reinforcing steel and prestressing strands to maintain at least 3/4-inch minimum concrete cover. Increase cover requirements for reinforcing steel to 1-

- 1/2 inches when units are exposed to corrosive environment or severe exposure conditions. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position while placing concrete. Direct wire tie ends away from finished, exposed concrete surfaces.
4. Install welded wire reinforcement in lengths as long as practicable. Lap adjoining pieces at least one full mesh spacing and wire tie laps, where required by design. Offset laps of adjoining widths to prevent continuous laps in either direction.
- F. Reinforce architectural precast concrete units to resist handling, transportation, and erection stresses and specified in-place loads.
- G. Prestress tendons for architectural precast concrete units by either pretensioning or post-tensioning methods. Comply with PCI MNL 117.
1. Delay detensioning or post-tensioning of precast, prestressed architectural concrete units until concrete has reached its indicated minimum design release compressive strength as established by test cylinders cured under same conditions as concrete unit.
 2. Detension pretensioned tendons either by gradually releasing tensioning jacks or by heat-cutting tendons, using a sequence and pattern to prevent shock or unbalanced loading.
 3. If concrete has been heat cured, detension while concrete is still warm and moist to avoid dimensional changes that may cause cracking or undesirable stresses.
 4. Protect strand ends and anchorages with bituminous, zinc-rich, or epoxy paint to avoid corrosion and possible rust spots.
- H. Comply with requirements in PCI MNL 117 and requirements in this Section for measuring, mixing, transporting, and placing concrete. After concrete batching, no additional water may be added.
- I. Place face mixture to a minimum thickness after consolidation of the greater of 1 inch or 1.5 times the maximum aggregate size, but not less than the minimum reinforcing cover specified.
- J. Place concrete in a continuous operation to prevent cold joints or planes of weakness from forming in precast concrete units.
1. Place backup concrete mixture to ensure bond with face-mixture concrete.
- K. Thoroughly consolidate placed concrete by internal and external vibration without dislocating or damaging reinforcement and built-in items, and minimize pour lines, honeycombing, or entrapped air voids on surfaces. Use equipment and procedures complying with PCI MNL 117.
1. Place self-consolidating concrete without vibration according to PCI TR-6, "Interim Guidelines for the Use of Self-Consolidating Concrete in Precast/Prestressed Concrete Institute Member Plants." Ensure adequate bond between face and backup concrete, if used.
- L. Comply with PCI MNL 117 for hot- and cold-weather concrete placement.
- M. Identify pickup points of architectural precast concrete units and orientation in structure with permanent markings, complying with markings indicated on Shop Drawings. Imprint or permanently mark casting date on each architectural precast concrete unit on a surface that does not show in finished structure.
- N. Cure concrete, according to requirements in PCI MNL 117, by moisture retention without heat or by accelerated heat curing using low-pressure live steam or radiant

heat and moisture. Cure units until compressive strength is high enough to ensure that stripping does not have an effect on performance or appearance of final product.

- O. Discard and replace architectural precast concrete units that do not comply with requirements, including structural, manufacturing tolerance, and appearance, unless repairs meet requirements in PCI MNL 117 and Architect's approval.

2.14 INSULATED PANEL ACCESSORIES

- A. Product: Subject to compliance with the requirements provide Composite Technologies Corporation; Thermomass Building System.
- B. Extruded-Polystyrene (XPS) Board Insulation: ASTM C 578, Type IV, 1.55 lb/cu. ft; square edges.
 - 1. Compressive resistance: 25 psi minimum at yield or at 10 percent deformation per ASTM D1621.
 - 2. Water Absorption: 0.1 percent maximum by volume per ASTM C272.
 - 3. ISR R-Value: 5.0°F•ft²•h/Btu per inch at 75° F minimum per ASTM C518. Warranted R-Value to retain minimum of 90 percent of its published R-value for 15 years.
 - 4. Manufactured with a blowing agent that provides at least a 90 percent reduction in potential for ozone depletion as compared to standard CFC blowing agents
 - 5. Supplied with holes to identify connector placements at designated spacing through insulation board surfaces. Provide holes sized for close fit with connectors.
- C. Structurally Non-Composite Wythe Connectors: As follows:
 - 1. Non-conductive, non-corrosive, fiber-composite connectors, having a tensile strength of 120,000 psi, minimum, glass content of 76 percent by weight, and a coefficient of thermal expansion of 5x10⁻⁶ in/in/deg F, nominal.
 - 2. ICC-ES Evaluation Service Report based on data submitted in accordance with ICC-ES Acceptance Criteria 320 indicating compliance with the applicable building code.

2.15 INSULATED PANEL CASTING

- A. Cast, screed, and consolidate bottom concrete wythe supported by mold.
- B. Place insulation boards abutting edges and ends of adjacent boards. Insert wythe connectors through insulation holes, and consolidate concrete around connectors according to connector manufacturer's written instructions.
- C. Ensure bottom wythe and insulation layer are not disturbed after bottom wythe reaches initial set.
- D. Cast, screed, and consolidate top wythe to meet required finish.
- E. Maintain temperature below 150 deg F in bottom concrete wythe.

2.16 FABRICATION TOLERANCES

- A. Fabricate architectural precast concrete units to shapes, lines, and dimensions indicated so each finished unit complies with PCI MNL 117 product tolerances as well as position tolerances for cast-in items.
- B. Fabricate architectural precast concrete units to shapes, lines, and dimensions

indicated so each finished unit complies with the following product tolerances:

1. Overall Height and Width of Units, Measured at the Face Exposed to View: As follows:
 - a. 10 feet or under, plus or minus 1/8 inch.
 - b. 10 to 20 feet, plus 1/8 inch, minus 3/16 inch.
 - c. 20 to 40 feet, plus or minus 1/4 inch.
 - d. Each additional 10 feet, plus or minus 1/16 inch.
 2. Overall Height and Width of Units, Measured at the Face Not Exposed to View: As follows:
 - a. 10 feet or under, plus or minus 1/4 inch.
 - b. 10 to 20 feet, plus 1/4 inch, minus 3/8 inch.
 - c. 20 to 40 feet, plus or minus 3/8 inch.
 - d. Each additional 10 feet, plus or minus 1/8 inch.
 3. Total Thickness or Flange Thickness: Plus 1/4 inch, minus 1/8 inch.
 4. Rib Thickness: Plus or minus 1/8 inch.
 5. Rib to Edge of Flange: Plus or minus 1/8 inch.
 6. Distance between Ribs: Plus or minus 1/8 inch.
 7. Variation from Square or Designated Skew (Difference in Length of the Two Diagonal Measurements): Plus or minus 1/8 inch/72 inches or 1/2 inch total, whichever is greater.
 8. Length and Width of Block-outs and Openings within One Unit: Plus or minus 1/4 inch.
 9. Location and Dimension of Block-outs Hidden from View and Used for HVAC and Utility Penetrations: Plus or minus 3/4 inch.
 10. Dimensions of Haunches: Plus or minus 1/4 inch.
 11. Haunch Bearing Surface Deviation from Specified Plane: Plus or minus 1/8 inch.
 12. Difference in Relative Position of Adjacent Haunch Bearing Surfaces from Specified Relative Position: Plus or minus 1/4 inch.
 13. Bowing: Plus or minus L/360, maximum 1 inch.
 14. Local Smoothness: 1/4 inch/10 feet.
 15. Warping: 1/16 inch/12 inches of distance from nearest adjacent corner.
 16. Tipping and Flushness of Plates: Plus or minus 1/4 inch.
 17. Dimensions of Architectural Features and Rustications: Plus or minus 1/8 inch.
- C. Position Tolerances: For cast-in items measured from datum line location, as indicated on Shop Drawings.
1. Weld Plates: Plus or minus 1 inch.
 2. Inserts: Plus or minus 1/2 inch.
 3. Handling Devices: Plus or minus 3 inches.
 4. Reinforcing Steel and Welded Wire Reinforcement: Plus or minus 1/4 inch where position has structural implications or affects concrete cover; otherwise, plus or minus 1/2 inch.
 5. Reinforcing Steel Extending out of Member: Plus or minus 1/2 inch of plan dimensions.
 6. Tendons: Plus or minus 1/4 inch, vertical; plus or minus 1 inch, horizontal.
 7. Location of Rustication Joints: Plus or minus 1/8 inch.
 8. Location of Opening within Panel: Plus or minus 1/4 inch.
 9. Location of Flashing Reglets: Plus or minus 1/4 inch.
 10. Location of Flashing Reglets at Edge of Panel: Plus or minus 1/8 inch.
 11. Reglets for Glazing Gaskets: Plus or minus 1/8 inch.
 12. Electrical Outlets, Hose Bibs: Plus or minus 1/2 inch.
 13. Location of Bearing Surface from End of Member: Plus or minus 1/4 inch.

14. Allowable Rotation of Plate, Channel Inserts, and Electrical Boxes: 2-degree rotation or 1/4 inch maximum over the full dimension of unit.
15. Position of Sleeve: Plus or minus 1/2 inch.
16. Location of Window Washer Track or Buttons: Plus or minus 1/8 inch.

2.17 FINISHES

- A. Exposed faces shall be free of joint marks, grain, and other obvious defects. Corners, including false joints shall be uniform, straight, and sharp. Finish exposed-face surfaces of architectural precast concrete units to match approved design reference sample.
- B. Finish exposed top and back surfaces of architectural precast concrete units with smooth, steel-trowel finish.
- C. Finish unexposed surfaces of architectural precast concrete units with as cast finish.

2.18 SOURCE QUALITY CONTROL

- A. Quality-Control Testing: Test and inspect precast concrete according to PCI MNL 117 requirements. If using self-consolidating concrete, also test and inspect according to PCI TR-6, ASTM C 1610/C 1610M, ASTM C 1611/C 1611M, ASTM C 1621/C 1621M, and ASTM C 1712.
- B. Owner will employ an independent testing agency to evaluate architectural precast concrete fabricator's quality-control and testing methods.
 1. Allow Owner's testing agency access to material storage areas, concrete production equipment, concrete placement, and curing facilities. Cooperate with Owner's testing agency and provide samples of materials and concrete mixtures as may be requested for additional testing and evaluation.
- C. Strength of precast concrete units is considered deficient if units fail to comply with [ACI 318](#) requirements for concrete strength.
- D. Testing: If there is evidence that strength of precast concrete units may be deficient or may not comply with [ACI 318](#) requirements, precaster will employ an independent testing agency to obtain, prepare, and test cores drilled from hardened concrete to determine compressive strength according to ASTM C 42/C 42M and [ACI 318](#).
 1. A minimum of three representative cores shall be taken from units of suspect strength, from locations directed by Architect.
 2. Test cores in an air-dry condition.
 3. Strength of concrete for each series of three cores is considered satisfactory if average compressive strength is equal to at least 85 percent of 28-day design compressive strength and no single core is less than 75 percent of 28-day design compressive strength.
 4. Report test results in writing on same day that tests are performed, with copies to Architect, Contractor, and precast concrete fabricator. Test reports include the following:
 - a. Project identification name and number.
 - b. Date when tests were performed.
 - c. Name of precast concrete fabricator.
 - d. Name of concrete testing agency.
 - e. Identification letter, name, and type of precast concrete unit(s) represented by core tests; design compressive strength; type of break; compressive strength at breaks, corrected for length-diameter ratio; and direction of

applied load to core in relation to horizontal plane of concrete as placed.

- E. Patching: If core test results are satisfactory and precast concrete units comply with requirements, clean and dampen core holes and solidly fill with precast concrete mixture that has no coarse aggregate, and finish to match adjacent precast concrete surfaces.
- F. Defective Units: Discard and replace recast architectural concrete units that do not comply with acceptability requirements in PCI MNL 117, including concrete strength, manufacturing tolerances, and color and texture range. Chipped, spalled, or cracked units may be repaired, subject to Architect's approval. Architect reserves the right to reject precast units that do not match approved samples, sample panels, and mockups. Replace unacceptable units with precast concrete units that comply with requirements.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine supporting structural frame or foundation and conditions for compliance with requirements for installation tolerances, bearing surface tolerances, and other conditions affecting performance of the Work.
- B. Do not install precast concrete units until supporting cast-in-place concrete has attained minimum allowable design compressive strength and supporting steel or other structure is structurally ready to receive loads from precast concrete units.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install clips, hangers, bearing pads, and other accessories required for connecting architectural precast concrete units to supporting members and backup materials.
- B. Erect architectural precast concrete level, plumb, and square within specified allowable tolerances. Provide temporary supports and bracing as required to maintain position, stability, and alignment of units until permanent connections are completed.
 - 1. Install temporary steel or plastic spacing shims as precast concrete units are being erected. Tack weld steel shims to each other to prevent shims from separating.
 - 2. Maintain horizontal and vertical joint alignment and uniform joint width as erection progresses.
 - 3. Remove projecting lifting devices and grout fill voids within recessed lifting devices flush with surface of adjacent precast surfaces when recess is exposed.
 - 4. Unless otherwise indicated, maintain uniform joint widths of $3/4$ inch.
- C. Connect architectural precast concrete units in position by bolting, welding, grouting, or as otherwise indicated on Shop Drawings. Remove temporary shims, wedges, and spacers as soon as practical after connecting and grouting are completed.
 - 1. Do not permit connections to disrupt continuity of roof flashing.
- D. Welding: Comply with applicable requirements in AWS D1.1/D1.1M and AWS D1.4/D1.4M for welding, welding electrodes, appearance, quality of welds, and methods used in correcting welding work.

1. Protect architectural precast concrete units and bearing pads from damage by field welding or cutting operations, and provide noncombustible shields as required.
 2. Welds not specified shall be continuous fillet welds, using no less than the minimum fillet as specified by AWS.
 3. Clean weld-affected metal surfaces with chipping hammer followed by brushing, and apply a minimum 4.0-mil- thick coat of galvanized repair paint to galvanized surfaces according to ASTM A 780/A 780M.
 4. Clean weld-affected metal surfaces with chipping hammer followed by brushing, and reprime damaged painted surfaces.
 5. Visually inspect welds and remove, reweld, or repair incomplete and defective welds.
- E. At bolted connections, use lock washers, tack welding, or other approved means to prevent loosening of nuts after final adjustment.
1. Where slotted connections are used, verify bolt position and tightness. For sliding connections, properly secure bolt but allow bolt to move within connection slot.
 2. For slip-critical connections, use one of the following methods to assure proper bolt pretension:
 - a. Turn-of-Nut: According to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
 - b. Calibrated Wrench: According to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
 - c. Twist-off Tension Control Bolt: ASTM F 1852.
 - d. Direct-Tension Control Bolt: ASTM F 1852.
 3. For slip-critical connections, use method and inspection procedure approved by Architect and coordinated with inspection agency.
- F. Grouting or Dry-Packing Connections and Joints: Grout connections where required or indicated. Retain flowable grout in place until hard enough to support itself. Alternatively, pack spaces with stiff dry-pack grout material, tamping until voids are completely filled. Place grout and finish smooth, level, and plumb with adjacent concrete surfaces. Promptly remove grout material from exposed surfaces before it affects finishes or hardens. Keep grouted joints damp for not less than 24 hours after initial set.

3.03 ERECTION TOLERANCES

- A. Erect architectural precast concrete units level, plumb, square, and in alignment without exceeding the noncumulative erection tolerances of PCI MNL 117, Appendix I.
- B. Erect architectural precast concrete units level, plumb, square, and in alignment, without exceeding the following noncumulative erection tolerances:
1. Plan Location from Building Grid Datum: Plus or minus 1/2 inch.
 2. Plan Location from Centerline of Steel: Plus or minus 1/2 inch.
 3. Top Elevation from Nominal Top Elevation: As follows:
 - a. Exposed Individual Panel: Plus or minus 1/4 inch.
 - b. Non-Exposed Individual Panel: Plus or minus 1/2 inch.
 - c. Exposed Panel Relative to Adjacent Panel: 1/4 inch.
 - d. Non-Exposed Panel Relative to Adjacent Panel: 1/2 inch.

4. Support Elevation from Nominal Support Elevation: As follows:
 - a. Maximum Low: 1/2 inch.
 - b. Maximum High: 1/4 inch.
5. Maximum Plumb Variation over the Lesser of Height of Structure or 100 Feet: 1 inch.
6. Plumb in Any 10 Feet of Element Height: 1/4 inch.
7. Maximum Jog in Alignment of Matching Edges: 1/4 inch.
8. Joint Width (Governs over Joint Taper): Plus or minus 1/4 inch.
9. Maximum Joint Taper: 3/8 inch.
10. Joint Taper in 10 Feet: 1/4 inch.
11. Maximum Jog in Alignment of Matching Faces: 1/4 inch.
12. Differential Bowing or Camber, as Erected, between Adjacent Members of Same Design: 1/4 inch.
13. Opening Height between Spandrels: Plus or minus 1/4 inch.

3.04 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections and prepare reports:
 1. Erection of loadbearing precast concrete members.
- B. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections and prepare test reports.
- C. Visually inspect field welds and test according to ASTM E 165 or to ASTM E 709 and ASTM E 1444. High-strength bolted connections are subject to inspections.
- D. Testing agency will report test results promptly and in writing to Contractor and Architect.
- E. Repair or remove and replace work where tests and inspections indicate that it does not comply with specified requirements.
- F. Additional testing and inspecting, at Contractor's expense, shall be performed to determine compliance of replaced or additional work with specified requirements.

3.05 REPAIRS

- A. Repair architectural precast concrete units if permitted by Architect. Architect reserves the right to reject repaired units that do not comply with requirements.
- B. Mix patching materials and repair units so cured patches blend with color, texture, and uniformity of adjacent exposed surfaces and show no apparent line of demarcation between original and repaired work, when viewed in typical daylight illumination from a distance of 20 feet.
- C. Prepare and repair damaged galvanized coatings with galvanizing repair paint according to ASTM A 780/A 780M.
- D. Wire brush, clean, and paint damaged prime-painted components with same type of shop primer.
- E. Remove and replace damaged architectural precast concrete units when repairs do not comply with requirements.

3.06 CLEANING

- A. Clean surfaces of precast concrete units exposed to view.
- B. Clean mortar, plaster, fireproofing, weld slag, and other deleterious material from concrete surfaces and adjacent materials immediately.
- C. Clean exposed surfaces of precast concrete units after erection and completion of joint treatment to remove weld marks, other markings, dirt, and stains.
 - 1. Perform cleaning procedures, if necessary, according to precast concrete fabricator's recommendations. Protect other work from staining or damage due to cleaning operations.
 - 2. Do not use cleaning materials or processes that could change the appearance of exposed concrete finishes or damage adjacent materials.

END OF SECTION 03 45 00

SECTION 03 53 14**QUARTZ-AGGREGATE CONCRETE TOPPING - LIGHT REFLECTIVE****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.01 SUMMARY

- A. Section Includes monolithic, light-reflective, quartz-aggregate concrete floor topping applied to fresh concrete of base slabs.
- B. Related Sections:
 - 1. Division 03 Section "Cast-In-Place Concrete" for concrete base mix beneath topping, and for joint fillers.

1.02 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Qualification Data: For Installer.
- C. Installer Certificates: Signed by manufacturer certifying that installers comply with specified requirements.
- D. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for concrete floor topping.
- E. Field quality-control test reports.

1.03 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an experienced installer (applicator) who is experienced in applying concrete floor toppings similar in material, design, and extent to those indicated for this Project, whose work has resulted in applications with a record of successful in-service performance, and who is acceptable to concrete topping manufacturer.
 - 1. Engage an installer who employs only persons trained and approved concrete topping manufacturer for applying concrete topping indicated.
 - 2. Engage an installer who is certified in writing by concrete topping manufacturer as qualified to apply concrete topping indicated.
- B. Testing Agency Qualifications: An independent agency qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.
- B. Mockups: Place concrete floor topping mockups to demonstrate typical joints, surface finish, texture, tolerances, and standard of workmanship.
 - 1. Build mockups approximately 100 sq. ft. in the location indicated or, if not indicated, as directed by Architect.
 - 2. If Architect determines that mockups do not meet requirements, demolish and

- remove them from the site and cast others until mockups are approved.
3. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

C. Preinstallation Conference: Conduct conference at Project site.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in original packages and containers, with seals unbroken, bearing manufacturer's labels indicating brand name and directions for storage, mixing with other components, and application.
- B. Store materials to comply with manufacturer's written instructions to prevent deterioration from moisture or other detrimental effects.

1.05 PROJECT CONDITIONS

- A. Environmental Limitations: Comply with manufacturer's written instructions for substrate temperature and moisture content, ambient temperature and humidity, ventilation, and other conditions affecting concrete floor topping performance.
 1. Place concrete floor topping only when ambient temperature and temperature of base slabs are between 50 and 86 deg F.
- B. Close areas to traffic during topping application and, after application, for time period recommended in writing by manufacturer.

PART 2 - PRODUCTS

2.01 CONCRETE FLOOR TOPPING

- A. Light Reflective Mineral Dry-Shake Floor Hardener: Factory-prepared and dry-packaged mixture of finely graded quartz aggregate; portland cement or blended hydraulic cement; light reflective pigments; plasticizers; and other admixtures; ready for shake-on application. Use light reflective pigments that are finely ground, nonfading mineral oxides interground with cement.
 1. Light Reflectance: Hardener shall increase by more than 60 percent the light reflective properties of a similarly finished floor surface using concrete base slab mix provided.
 1. Reflectance values for light reflective type hardener shall be submitted in accordance with this Section's Article "Submittals" and shall be determined using the "Known Sample" method. "Known Sample" finish sample shall have a 60 percent light reflective value and shall be used as the basis for determining light reflective value of reflective type surface hardener specified to comply with the reflective value requirements. Luminance shall be measured using an accurate laboratory type instrument.
 2. Available Products:
 - a. Conspec Marketing & Manufacturing Co., Inc., a Dayton Superior Company; Conshake 700.
 - b. Euclid Chemical Company (The); Surfex Light Reflective.
 - c. L&M Construction Chemicals, Inc.; Quartz Plate FF Light Reflective.
 - d. US Mix; US SPEC Densetop LR.
 3. Compressive Strength (28 Days): 10,000 psi; ASTM C 109/C 109M.

2.02 CURING MATERIALS

- A. Clear, Waterborne, Membrane-Forming Curing And Temporary Sealing Compound: Manufacturer's recommended formulation complying with ASTM C 309, Type 1, Class B, 25 percent solids content, minimum; and ASTM C 1315, except for white pigment provisions.
 - 1. Available Products:
 - a. Euclid Chemical Company; Super Aquacare VOX, except provide Kurez DR if recommended by manufacturer for use with permanent sealer.
 - b. L & M Construction Chemicals, Inc.; Dress & Seal WB/#30, except provide L&M Cure DR if recommended by manufacturer for use with permanent sealer.
 - c. Chemrex Inc.; MasterKure.
 - d. US Mix; US SPEC Maxcure Resin Clear.

2.03 RELATED MATERIALS

- A. Semirigid Joint Filler: Two-component, semirigid, 100 percent solids, epoxy resin with a Type A Shore durometer hardness of 80 per ASTM D 2240.
 - 1. Available Products:
 - a. US Mix; US SPEC SR 50-EJF.
 - b. L&M Construction Chemicals, Inc.; Epoflex SL.

2.04 FLOOR SEALING MATERIALS

- A. Penetrating Sealer: Water-based, silicate sealer designed to increase concrete floor resistance to heavy duty abrasion, tire marking and staining.
 - 1. Available Products:
 - a. US Mix; US SPEC Industraseal.
 - b. Euclid Chemical Company; Euco Diamond Hard.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates, with Installer present, for conditions affecting performance of concrete floor topping. Verify that joint filler strips have been installed where topping abuts vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.
- B. Proceed with application only after unsatisfactory conditions have been corrected.

3.02 FLOOR TOPPING APPLICATION

- A. Start floor topping application in presence of manufacturer's technical representative.
- B. Float surface of base slab concrete in accordance with Division 03 Section "Cast-In-Place Concrete."
- C. After float finish is applied to fresh base slab concrete, and while concrete is still plastic, shake apply concrete floor topping by evenly distributing a minimum total of

1-1/2 lbs. of aggregate per sq. ft. in not less than 2 applications.

1. Control concrete moisture as recommended by topping manufacturer when floated finish is subject to rapid surface drying by wind, by sunlight, and by abutting construction dry enough to draw moisture from the plastic concrete. Apply topping in these areas first.

D. First Topping Application:

1. Apply not less than 1 lb. of topping to each sq. ft. surface of fresh concrete.
2. Distribute evenly.
3. If topping material breaks through floated surface of concrete, then it is too plastic for topping application.
4. Float topping after it has darkened slightly from moisture absorption. Use only wood floats (do not use metal floats, or combinations of wood and metal floats). Continue floating until moisture from underlying concrete has been worked completely through topping. (If moisture from underlying concrete does not work through first application of topping, second application will delaminate.) Restraighten, cut down high spots, and fill low spots.

E. Second Topping Application: Apply immediately after first application of topping has been floated.

1. Precautions: If any of the following finish blemishes occur during second topping application, obtain immediate instruction from manufacturer's technical representative.
 - a. Premature surface drying.
 - b. Trowel-burn.
 - c. Blistering and bubbling.
2. Apply not less than 1/2 lb. of topping to each sq. ft. of concrete surface.
3. Distribute evenly and at right angles to first topping application.
4. In same manner as first topping, float topping after it has darkened slightly. Continue floating until moisture from underlying surface has been worked completely through topping. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraightening until concrete floor topping surface has a uniform, smooth, granular texture. Do not add water to aid finishing operations.
5. Hard Trowel Finish: After floating surface, apply trowel finish. Use only stainless steel finishing tools and trowel blades (do not use magnesium metal tools). Continue troweling passes and restraighten until surface is smooth and uniform in texture.
 - a. Finish and measure surface so gap at any point between surface and an unlevelled freestanding 10-foot long straightedge, resting on 2 high spots and placed anywhere on the surface, does not exceed 1/4 inch.

F. Construction Joints: Construct joints true to line with faces perpendicular to surface plane of concrete floor topping, at locations indicated or as approved by Architect.

G. Contraction Joints: Form weakened-plane contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- wide joints into concrete floor topping when cutting action will not tear, abrade, or otherwise damage surface and before random contraction cracks develop.

1. Construct contraction joints for a combined depth equal to topping thickness and not less than one-fourth of base-slab thickness.

3.03 PROTECTING AND CURING

- A. General: Protect freshly placed concrete floor topping from premature drying and excessive cold or hot temperatures.
- B. Evaporation Retarder: Apply evaporation retarder to concrete floor topping surfaces in hot, dry, or windy conditions before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying floor topping, but before float finishing.
- C. Begin curing immediately after finishing concrete floor topping. Cure by the following method, according to concrete floor topping manufacturer's written instructions:
 - 1. Curing Compound: Apply uniformly in two coats in continuous operations by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

3.04 JOINT FILLING

- A. Prepare and clean contraction joints and install semirigid joint filler, according to manufacturer's written instructions, once topping has fully cured.
- B. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joint clean and dry.
- C. Install semirigid joint filler full depth of contraction joints. Overfill joint and trim semirigid joint filler flush with top of joint after hardening.

3.05 REPAIRS

- A. Defective Topping: Repair and patch defective concrete floor topping areas, including areas that have not bonded to concrete substrate.

3.06 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Testing Services: Testing and inspecting of completed applications of concrete floor toppings shall take place in successive stages, in areas of extent and using methods as follows:
 - 1. Concrete floor topping shall be tested for delamination by dragging a steel chain over the surface.
 - 2. Concrete floor topping shall be tested for compliance with surface flatness and levelness tolerances.
- C. Remove and replace applications of concrete floor topping where test results indicate that it does not comply with specified requirements.
- D. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

END OF SECTION 03 53 14

SECTION 03 60 00**GROUTING****PART I - GENERAL****1.1 SUMMARY**

- A. Description: The Work specified in this Section consists of furnishing, mixing and placing non-shrink, non-metallic, non-corrosive Portland cement grout for structural members and base plate bearing and as indicated on the Contract Drawings, or specified herein. The work includes labor, material, tools, and equipment as required.

1.2 REFERENCES

<u>Sponsor</u>	<u>Number</u>	<u>Subject</u>
ASTM	C 1107	Standard Specification for Packaged Dry, Hydraulic-cement Grout (Non-shrink)
AASHTO	T 106-04	Standard Test Method for Comprehensive Strength of Hydraulic Cement Mortar
ASTM	C 827	Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens of Cementitious Mixtures

1.3 SUBMITTALS

- A. Submittal shall be made in accordance with the requirements of the Project Quality Plan, except as modified herein.
- B. Manufacturer's Product Data Sheets including laboratory results, recommended uses, instructions, and limitations.
- C. Certificates - Submit laboratory test reports showing;
1. Materials used in the grout are free of metallic components, corrosion-producing elements.
 2. Materials meet specified non-shrinkage and compressive strength requirements.
 3. Materials comply with ASTM C 1107.
- D. Manufacturer's Instructions shall include recommended mixing procedure and installation steps, water volume, workability times, and temperatures.

1.4 QUALITY CONTROL

- A. Quality control shall be made in accordance with the requirements of the Project Quality Plan, except as modified herein.
- B. Acceptable manufacturers shall be regularly engaged in the manufacturing of non-shrink, non-metallic, non-corrosive grout.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Deliver and store grout materials in undamaged original protective packaging with seals and labels intact.
- B. Prevent damage to, or contamination of, grout material all the time.

PART II - PRODUCTS**2.1 MATERIALS**

- A. Non-shrink, non-metallic, non-corrosive grout shall conform to the following:
 - 1. ASTM C 1107.
 - 2. Manufactured specifically for use in transferring heavy loads.
 - 3. Grout shall show no shrinkage when tested under ASTM-C827.
 - 4. Compressive strength at 28 days shall be at least 4000 psi.
 - 5. Resistant to attack by oil and water.
- B. Water used in mixing shall be free of deleterious chemicals affecting grout components.
- C. Use of air-entraining agents or admixtures is prohibited.
- D. Pre-approved products: US Spec Multi Purpose Grout, US Spec General Purpose Grout.

2.2 PRODUCTION

- A. Mix grouting materials and water in mechanical mixer. Measure aggregate materials in a damp, loose condition.
- B. Mix grout as close to work area as possible.
- C. Transport grout mix in a manner that does not permit separation of materials.
- D. Do not re-temper or add additional water after grout has been mixed.

PART III - EXECUTION**3.1 SURFACE PREPARATION**

- A. Remove defective concrete, laitance, dirt, oil, grease, and other foreign materials from concrete surfaces by chipping, or other means, until sound, clean concrete surfaces are achieved.
- B. Lightly roughen concrete, but not enough to interfere with proper placement of grout.
- C. Cover concrete areas with protective waterproof membrane or sheet until ready to grout.
- D. Remove foreign materials from steel surfaces in contact with grout.

- E. Align and level components to be grouted and maintain in final position until grouting is complete and accepted.
- F. Remove protective waterproof covering; clean surfaces immediately before grouting.
- G. Saturate concrete surfaces with clean water; remove excess water, with none left standing, immediately before grouting.

3.2 GROUT PLACEMENT

- A. Place grout continuously by gravity flow or under pressurized methods.
- B. Apply grout from one side only to avoid air entrapment.
- C. Thoroughly strap final installation so as to be free from air pockets.
- D. Do not vibrate grout mixture after placing; do not place grout if the grouting area is being vibrated by nearby equipment.
- E. Do not remove leveling shims, if used, for at least 48 hours after grout has been placed.
- F. Fill shim voids with non-shrink, non-corrosive grout, packing the material with suitable tool.
- G. Do not use grout that has begun to set or if more than 1- 1/2 hours have elapsed, after initial mixing.

3.3 CURING

- A. Cure grout for a minimum of two hours after placing by keeping wet and covering with high wet strength Kraft paper or by other acceptable methods.

PART IV - MEASUREMENT

- 4.1 **Measurement** – No Separate measurement will be made for Work described in this Section.

PART V - PAYMENT

- 5.1 **Payment** – Payment for items in this Section will be incidental to the Contract unit cost of the concrete bid items.

END OF SECTION

SECTION 03 64 23**EPOXY INJECTION GROUTING****PART I - GENERAL****1.1 SUMMARY****A. Description**

This work includes repair of cracks by injection epoxy and sealing concrete surfaces as identified by inspections reports, QA/QC and as specified herein. This work shall be constructed in accordance with these specifications and in conformity with the lines, grades, dimensions and notes shown on the Contract Drawings or presented by the Engineer. The work includes material, equipment, and labor necessary to procure, fabricate, prepare, and install in field the concrete repair.

1.2 REFERENCES

<u>Sponsor</u>	<u>Number</u>	<u>Subject</u>
MoDOT	Section 1039	Epoxy Resin Material, 2011 Missouri Standard Specification Book for Highway Construction

1.3 SUBMITTALS**A. Submittals shall be made in accordance with the requirements of the Project Quality Plan, except as modified herein.**

1. Prior to repairing the concrete the product review, data sheets, and repair procedure shall be submitted to the Engineer for review and approval for each repair. Include as needed special mixing procedures and site preparation procedures as applicable.

B. Inspection reports for each repair indicating structure and location.**1.4 QUALITY CONTROL**

Quality control shall be made in accordance with the Engineer in addition to the requirements of the Project Quality Plan except as modified herein.

1.5 ACCEPTANCE

Penetration of 95% of all cracks from 1/64 inch to 1/4 inch is required.

PART II - PRODUCTS**2.1 MATERIALS****A. Select from the Division 1000 maintained by MoDOT.**

1. Epoxy Injection Material:

- a) Use only products for which vertical crack injection is recommended by the manufacturer.
 - b) Use appropriate cap seal material recommended by the particular epoxy manufacturer.
2. Surface Sealing Material: Penetrating sealer.

2.2 EQUIPMENT

- A. Minimum of two pumps with the following required characteristics:
 1. Electric-powered and portable.
 2. Positive displacement.
 3. Positive-ratio control of exact proportions of the two components at the nozzle.
 4. In-line metering and mixing.
- B. Injection equipment required characteristics:
 1. Automatic pressure control capable of discharging the mixed adhesive at any pre-set pressure up to 200 psi \pm 0.5 psi.
 2. Equipped with a manual pressure control override.
- C. Capable of maintaining the volume ratio of the injection material prescribed by the manufacturer within a tolerance of \pm 5% by volume at any discharge pressure up to 200 psi.
- D. With sensors on both the component A and B reservoirs that automatically stop the machine when only one component is being pumped to the mixing head.

PART III - EXECUTION

3.1 INSTALLERS

- A. Injection equipment operators must have a minimum of two years experience in the methods and materials of the selected system for application of epoxy injection.
- B. Injection equipment operators must know the technical aspects of:
 1. Correct material selection and use.
 2. Equipment operation, maintenance, and troubleshooting.

3.2 PREPARATION

- A. Sandblast clean the concrete surfaces
- B. Seal cracks.
- C. Provide entry ports for the epoxy injection. Space ports a maximum of 6 inches.

3.3 EPOXY SEALING

- A. Grind flush all ports extending above the concrete surfaces.
- B. Cover the entire length of the crack with epoxy sealant for a minimum of 2 ft on either side of the crack.
- C. Mask the member so a straight vertical line is produced at the cutoff point.
- D. Apply a second coat at the same application rate as soon as the first coat is dry to the touch. Do not exceed the following times between coats:

Hours	Temperature (Degrees F)
72	66
36	77
24	90

PART IV - MEASUREMENT

4.1 **Measurement** – No Separate measurement will be made for Work described in this Section.

PART V - PAYMENT

5.1 **Payment** – Payment for items in this Section will be incidental to the Contract unit cost of the concrete bid items.

END OF SECTION

SECTION 03 80 00**CONCRETE CUTTING AND BORING****PART I - GENERAL****1.1 SECTION INCLUDES**

- A. Saw or cut pavements, curb and gutter, sidewalk, driveway, and/or any appurtenances as required to provide a smooth surface to match.

PART II - PRODUCTS

NOT USED

PART III - EXECUTION**3.1 PROCEDURE - CONCRETE SURFACES**

- A. Saw cut vertically in a straight line through the full depth of the surface.
- B. Where the edge of the existing surface is cracked, broken, or deteriorated, make the cut so the defective surface can be removed.
- C. Water shall be used to control dust during sawing operations.
- D. Do not allow traffic or construction equipment to cross the cut edge.

3.2 PROCEDURE - ASPHALT SURFACES

- A. Use any method that provides a vertical cut in a straight line through the full depth of the surface.
 - 1. Saw cut at no additional cost to KCMO if the method of cutting does not produce a smooth, non-broken edge.
- B. Where the edge of the existing surface is cracked, broken, or deteriorated, make the cut so the defective surface can be removed.
- C. Water shall be used to control dust during sawing operations.
- D. Do not allow traffic or construction equipment to cross the cut edge.
- E. When appropriate, apply a tack coat to the cut edge before placing hot mix asphalt surfacing. Refer to Section 32 12 13.19.

PART IV - MEASUREMENT

- 4.1 Measurement** – No Separate measurement will be made for Work described in this Section.

PART V - PAYMENT

5.1 Payment – Payment for items in this Section will be incidental to the Contract unit cost of the concrete bid items.

END OF SECTION

SECTION 03 90 00**FLOWABLE FILL****PART I - GENERAL****1.1 SUMMARY**

- A. Description: This Section specifies materials and procedures for placing flowable fill.

1.2 REFERENCES

- A. AASHTO M 154: Air-Entraining Admixtures for Concrete.
- B. AASHTO M 194: Chemical Admixture for Concrete.
- C. ASTM C 150: Portland Cement.
- D. ASTM C 618: Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete.
- E. ASTM D 4832: Preparation and Testing of Controlled Low Strength Material (CLSM) Test.

1.3 SUBMITTALS

- A. Batch Proportions: Submit to Engineer seven days before placement.
- B. Trial Batch:
1. Submit certified test results or conduct laboratory trial batch to verify strength prior to placement.
 2. KCMO or its representative witnesses the trial batch.

PART II – PRODUCTS**2.1 MATERIALS**

- A. Portland Cement: ASTM C 150.
- B. Pozzolan: ASTM C 618.
- C. Sand.
- D. Coarse aggregate: Determine a suitable aggregate size and gradation for the intended application.
- E. Admixtures:
1. Water reducers and set accelerators: AASHTO M 194.
 2. Air entrainment: AASHTO M 154.

2.2 EQUIPMENT

- A. Equipment capable of supplying a homogenous product at the appropriate rate.
- B. Certified scales or measuring devices to measure delivered product and to proportion

product components.

PART III – EXECUTION

3.1 INSTALLATION

- A. Combine materials to meet the requirements for strength and constructability as required. Determine strength from trial batches at 28 days.
 - 1. Minimum strength: 50 psi. ASTM D 4832.
 - 2. Maximum strength: 150 psi. ASTM D 4832.
 - 3. Slump: 5 inches to 10 inches.
- B. Determine a suitable aggregate size and gradation for the intended application.

PART IV - MEASUREMENT

- 4.1 **Measurement** – No Separate measurement will be made for Work described in this Section.

PART V - PAYMENT

- 5.1 **Payment** – Not separate payment will be made for “Flowable Fill”. All costs pertaining thereto shall be included in the contract prices for other items as listed in the Bid Form of Unit Prices.

END OF SECTION

SECTION 04 05 05
COLD AND HOT WEATHER MASONRY PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish all labor, materials, tools, equipment, and services for Cold and Hot Weather Masonry Procedures, as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. As required to achieve desired results.

PART 3 - EXECUTION

3.1 PROCEDURES

- A. International Building Code, Chapter 21.
- B. Local Building Code.
- C. ACI 530.1/ASCE 6/TMS 602.
- D. Brick Industry Association, Technical Note 1.
- E. National Concrete Masonry Construction, Technical Note 3-1C.

3.2 GENERAL

- A. At end of each day or at shutdown, cover tops of walls not enclosed or sheltered.
- B. Do not use frozen or ice coated materials.
- C. Remove and replace frozen or damaged masonry to satisfaction of Architect.

3.3 TEMPORARY FACILITIES

- A. Construct and maintain temporary protection required to permit continuous and orderly progress of work.
- B. Provide temperature conditioning sufficient for indicated temperatures.
- C. Provide sufficient temporary lighting to permit work to be correctly performed.

END OF SECTION

SECTION 04 05 10 MASONRY CLEANING

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Masonry Cleaning in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 SUBMITTALS

- A. Project Information:
 - 1. Name of proposed product and manufacturer.
 - 2. Certification that the proposed products are compatible for materials on subject project.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Cleaners:
 - 1. Base:
 - a. ProSoCo.
 - 2. Optional:
 - a. EaCo Chem.
- B. Other manufacturers desiring approval comply with Section 00 26 00.

2.2 MATERIALS

- A. General:
 - 1. Use only products which are recommended by manufacturer of material to be cleaned.
- B. Concrete Masonry (CMU) Cleaners:
 - 1. General:
 - a. Clean CMU which will remain exposed to view (including CMU walls which are scheduled for painting).
 - 2. Lightweight and Normal Weight CMU:
 - a. Base Product: Sure Klean Custom Masonry Cleaner by ProSoCo.
- C. Cast-in-Place Concrete Cleaner:
 - 1. General:
 - a. Clean Cast-in-Place concrete walls which will remain exposed to view (including CIP walls which are scheduled for painting).
 - b. Clean with most effective products which are appropriate for texture and color specified.
 - 2. Sandblasted, Etched, and Exposed-aggregate Textures:
 - a. Base Product: Sure Klean Custom Masonry Cleaner or Heavy-duty Concrete Cleaner both by ProSoCo.
- D. Architectural Precast Concrete (APC) Cleaner:
 - 1. General:

-
- a. Clean with most effective products which are appropriate for texture and color specified.
 2. Sandblasted, Etched, and Exposed-aggregate Textures:
 - a. Base Product: Sure Klean Custom Masonry Cleaner or Heavy-duty Concrete Cleaner both by ProSoCo.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine surfaces to be cleaned.
 1. If necessary point with mortar.
- B. Waiting Time before cleaning:
 1. Mortar Type N: Allow mortar to cure for 14 to 28 days prior to cleaning.
 2. Mortar Types M and S: Allow mortar to cure for 7 to 14 days prior to cleaning.
 3. Colored Mortar: Allow mortar to fully cure 28 days prior to cleaning.
- C. Remove excess mortar using wooden paddles and scrapers.
- D. Do not proceed with cleaning until unsatisfactory conditions have been corrected.
- E. Test 4 x 4 FT area of each surface type for compatibility with cleaner, using recommended dilutions, prior to full scale cleaning operations.
- F. Cleaning indicates acceptance of surfaces and responsibility for performance.

3.2 PREPARATION

- A. Protect adjacent surfaces, not scheduled for cleaning.
- B. Prepare surfaces as recommended by manufacturer.

3.3 CLEANING

- A. Clean surfaces as recommended by manufacturer.
- B. Do not use wire brushes.
- C. Thoroughly rinse and pre-soak walls.
- D. Flush loose mortar and dirt from surface.
- E. Wet to prevent runoff streaking.
- F. Apply solution using fibered wall washing brush or low-pressure spray.
 1. Maximum Pressure: not to exceed 400 PSI.
 2. Tip spray angle: Not less than 25 Degrees.
 3. Maximum rate of flow: 4 to 6 GPM.
 4. Tip shall be held at least 12 IN from surface of masonry.
 5. Comply with manufacturer's recommendations, where more restrictive.
- G. Scrape off mortar and re-apply cleaning solution.
- H. After scrubbing, clean thoroughly with low pressure water.
 1. Comply with low-pressure spray criteria listed above.

END OF SECTION

SECTION 04 05 13
PORTLAND CEMENT-LIME (PCL) MORTARS & GROUT

PART 1 - GENERAL**1.1 SUMMARY**

- A. Furnish all labor, materials, tools, equipment, and services for Portland Cement-Lime (PCL) Mortars & Grout, as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

- A. Materials standards:
 - 1. ASTM C143 Standard Test Method for Slump of Hydraulic-Cement Concrete.
 - 2. ASTM C144 Standard Specification for Aggregate for Masonry Mortar.
 - 3. ASTM C150 Standard Specification for Portland Cement.
 - 4. ASTM C207 Standard Specification for Hydrated Lime for Masonry Purposes.
 - 5. ASTM C270 Specification for Unit Masonry.
 - 6. ASTM C404 Standard Specification for Aggregates for Masonry Grout.
 - 7. ASTM C476 Standard Specification for Grout for Masonry.
 - 8. ACI 530.1 Building Code Requirements and Specification for Masonry Structures.
 - 9. Brick Institute of America.
- B. Cold Weather Procedure: Specified in Section 04 05 05.
- C. Hot Weather Procedures:
 - 1. When ambient temperature is over 38 DegC over 100 DegF, or over 32 DegC over 90 DegF with a wind over 13 M/Hour over 8 MPH:
 - a. Monitor mortar temperature and maintain it between 21 to 49 DegC 70 to 120 DegF.
 - b. Limit spreading of bed mortar to 1200mm 4 FT, maximum, and place masonry units within 1 minute of spreading.
- D. Definitions:
 - 1. PCL Mortar: Portland Cement-Lime Mortar.
 - 2. PCL Grout: Portland Cement-Lime Grout.
 - 3. The use of masonry cement alone, or in combination with and PCL mixes, is prohibited.
 - 4. Factory Pre-Blended: Factory blend all mortar mix dry ingredients including; sand, cement, lime, pigments, etc.

1.3 SUBMITTALS**PART 2 - PRODUCTS****2.1 ACCEPTABLE MANUFACTURERS**

- A. Factory Pre-blended PCL Mortar:
 - 1. Base:
 - a. Spec Mix.
 - 2. Optional:
 - a. ProMix (U-mix).

- b. Quikrete.
 - c. ProSpec (Bonsal).
 - d. US Mix Company.
- B. Site-Mixed PCL Grout:
- 1. Base:
 - a. Products as indicated.
- C. Integral Waterproofing Mortar admixture, for mortar mixes used with Glass Unit Masonry Units at Exterior and/or Interior wet areas:
- 1. Base:
 - a. Sonneborn Building Products; Hydracide Powder.
 - 2. Optional:
 - a. Master Builders; Rheomix 235.
 - b. Laticrete 8510.
- D. Other manufacturers desiring approval comply with Section 00 26 00.

2.2 MATERIALS – PCL MORTARS

- A. Factory Pre-blended Mortar Mix:
- 1. Use approved mix designs which comply with ASTM C270, Property Method.
 - 2. Blend cementitious materials, aggregate and admixtures in factory under controlled conditions, which requires only addition of water at project site.
 - 3. Oven-dry aggregates prior to measuring and include in pre-blended mix.
- B. Portland Cement: ASTM C150, Type I, II or III.
- 1. Air-entraining cement is not permitted.
 - 2. Portland Cement Color: As indicated below for each application.
 - 3. Maximum percent of alkalis: 0.60.
- C. Hydrated lime: ASTM C207, Type S.
- D. Mortar aggregate:
- 1. ASTM C144.
 - 2. Aggregate Color: As indicated below for each application.
- E. Water: Potable.
- F. Do not use the following ingredients:
- 1. Do not use antifreeze additives.
 - 2. Do not use calcium chloride, thycyanates, or other materials containing chloride ions.
 - 3. Other admixtures: Not permitted without prior approval by Architect.
 - 4. Do not use ready mix mortar.
 - 5. Do not use masonry cement.

2.3 SCHEDULE OF MORTAR TYPES

- A. All PCL mortar mixes to comply with ASTM C270, property specification using component materials listed above:
- 1. Limit air content to 10 percent, maximum.
 - 2. Use appropriate type as indicated by following Table 4110A, for each condition.
 - 3. Not all conditions may apply to this Project.

TABLE 4110A - Basic Mortar Type Selection		
Location(s)	Building Segment	Mortar Type per ASTM C270
EXTERIOR MASONRY,	Foundation walls	M

TABLE 4110A - Basic Mortar Type Selection		
Location(s)	Building Segment	Mortar Type per ASTM C270
at or below grade	Retaining walls Sewers & manhole, and paving	
EXTERIOR MASONRY, above grade	Reinforced or Load Bearing brick / block walls Glass Unit Masonry Veneer Masonry, Parapets, and Chimneys >30 FT above grade Other areas with severe exposure	S
	Non-load bearing brick/block walls Veneer Masonry, where <30 FT above grade	N (or S)
	Parapets and chimneys where <30 FT above grade	N
INTERIOR MASONRY	Load bearing brick/block walls Non-load bearing brick/block walls Glass Unit Masonry Brick/block veneers	N

2.4 SCHEDULE OF MORTAR COLORS

- A. Use the following mortar colors in conjunction with Table 4110A to determine mixes of appropriate combinations of type and color for each project condition.
- B. Mortar Color MC-2:
 1. Location used:
 - a. CMU walls. See Section 04 22 00.
 2. Method:
 - a. Factory pre-blended mortar.
 3. Mortar Color:
 - a. Natural Grey, no pigment.
 4. Portland Cement Color:
 - a. Natural.
 5. Aggregate Color:
 - a. Natural.
- C. Mortar Color MC-3:
 1. Location used:
 - a. Glass Unit Masonry. See Section 04 23 00.
 2. Method:
 - a. Site-mixed mortar. Factory pre-blended mortar may be used at contractor's option.
 3. Mortar Color:
 - a. White.
 4. Portland Cement Color:
 - a. White.
 5. Aggregate Color:
 - a. White, silica sand.
 6. Reduce the amount of water in mortar mixes that will be used with glass unit masonry as required to account for their lack of absorptive properties.
 7. Do not re-temper mortar mixes used with glass unit masonry.

2.5 MATERIALS – PCL GROUT

- A. Site-mixed PCL Grout:
 1. Use approved mix designs.
 2. Mix on-site using approved materials as indicated.

3. Factory pre-blended dry grout mixes may be used at contractor's option.
 4. Ready-mixed product, delivered to site for direct placement in walls, may be used at contractor's option.
- B. PCL Grout Mixes – General:
1. Comply with ASTM C476.
 2. Portland Cement: ASTM C150, Type I, II or III.
 - a. Air-entraining cement is not permitted.
 - b. Maximum percent of alkalis: 0.60.
 - c. Not permitted: blended hydraulic cements including portland blast-furnace slag cement, portland-pozzolan cement, slag cement, and natural cement.
 3. Grout aggregate: ASTM C404.
 - a. Maximum Aggregate Size: 10mm 3/8 IN.
 - b. The use of blast furnace slag is not permitted.
 4. Hydrated lime:
 - a. ASTM C207, Type S.
 5. Water: Clean and potable.
 6. Other admixtures: Not permitted without prior approval by Architect.
 7. Compressive Strength: As indicated by GROUT MIX SCHEDULE, below, for each type.
 8. Slump for Grout Measured in accordance with ASTM-C143:
 - a. Minimum: 200mm 8 IN.
 - b. Maximum: 254mm 10 IN.

2.6 PCL GROUT MIX SCHEDULE

- A. Grout Mix GM-1:
1. Site mixed grout.
 - a. Redi-mixed or factory pre-blended may be used at contractor's option.
 2. Compressive Strength, 28-day:
 - a. Minimum 13 790 kPa 2000 PSI.
 3. Location used:
 - a. Fill for CMU walls.
 - b. Hollow metal door frames.
 - c. Elevator frames and sills.
 - d. Other indicated locations.
 4. Grout color: Natural grey, no pigment.
 5. Portland cement color: Natural.
 6. Aggregate color: Natural.
 7. Grout mixtures shall not contain gypsum.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with provisions of ACI 530 and ACI 530.1, except where exceeded by requirements of the contract documents.

3.2 MORTAR INSTALLATION

- A. Mix materials minimum of 5 minutes, but not more than 10 minutes.
- B. Adjust consistency to satisfaction of mason subject to compliance with specified criteria.
- C. Comply with BIA Standard MI-72.
- D. Install in accordance with BIA Standards.

- E. Strike all joints to create a uniformly concave final joint.
- F. If mortar begins to stiffen, it may be re-tempered in accordance with ASTM C270, Subparagraph 7.4.
- G. Use mortar within 2-1/2 hours of initial mixing.
- H. Remove units which are disturbed after laying. Clean off original mortar and reset with fresh mortar.

3.3 GROUT INSTALLATION

- A. Mix materials minimum of 5 minutes, but not more than 10 minutes.
- B. Use grout within 1-1/2 hours after initial mixing.
- C. Use coarse grout in spaces larger than 50mm 2 IN in both directions.
- D. Use fine grout in spaces with least dimension is less than 50mm 2 IN.
- E. Grout Installation – frames:
 - 1. Use fine grout for hollow metal door frames.
 - a. Grout frames of elevator hoistway openings.
 - b. Grout hollow metal door frames where the net opening is 1200mm 4 FT and greater.
- F. Grout installation - walls
 - a. See Section 04 22 00.

END OF SECTION

SECTION 04 05 23 MASONRY ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Masonry Accessories, as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

- A. Welding Standard: Perform welding in accordance with applicable provisions of AWS Structural Welding Code D1.1.
- B. Brick Industry Association Technical Notes on Brick Construction.
- C. ASTM standards indicated.
- D. Expansion Joints (versus Control Joints, Construction Joints etc):
 - 1. Movement joints used in brickwork are defined as Expansion Joints per BIA Technical Notes 18A.
 - a. Construct such Expansion Joints per BIA Technical Note 18A.
 - 2. Movement joints used in CMU work are defined as Control Joints by NCMA Tek 10-2B.
 - a. Construct such Control Joints per Tek 10-2B and other NCMA standards.

1.3 SUBMITTALS

- A. Project Information:
 - 1. Manufacturer literature for products proposed for use.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Masonry Anchors (adjustable wall ties):
 - 1. Base:
 - a. Hohmann & Barnard (H&B).
 - 2. Optional:
 - a. Wirebond.
 - b. Sandell.
- B. Cavity Protection Material:
 - 1. Base:
 - a. Mortar Net.
- C. Horizontal Reinforcing:
 - 1. Base:
 - a. Hohmann & Barnard (H&B).
 - 2. Optional:
 - a. Sandell Manufacturing Company, Inc.
 - b. Wire-Bond, Masonry Reinforcing Corp of America.
 - c. Heckmann.
- D. Pre-molded Control Joint Strips (at CJ's in CMU walls):

-
1. Base:
 - a. Hohmann & Barnard (H&B).
 2. Optional:
 - a. Everlastic.
 - b. Sandell Manufacturing Company, Inc.
 - c. Wire-Bond, Masonry Reinforcing Corp of America.
 - d. Heckmann.
- E. Galvanizing Repair Paint:
1. Base:
 - a. ZRC Worldwide.
 2. Optional:
 - a. Tnemec.
- F. Compressible Filler:
1. Base:
 - a. Hohmann & Barnard (H&B).
 2. Optional:
 - a. Sandell Manufacturing Company, Inc.
- G. Air Barrier: Specified in Division 07.
- H. Loose Lintels: Specified in Section 05 50 10.
- I. Structural Steel Lintels and Shelf Angles: Specified in Section 05 12 00 or 05 12 10.
- J. Other manufacturers desiring approval comply with Section 00 26 00.

2.2 HORIZONTAL REINFORCING

- A. Materials:
1. In interior walls:
 - a. Cold drawn steel wire, ASTM-A82, mill galvanized, ASTM-A641, Class 3 (0.80 OZ/SF).
 2. In walls surrounding wet areas with humidity over 70 percent (pools, showers, kitchens, food processing, wash bays):
 - 1) Stainless Steel, ASTM-A580 Type 304.
- B. Horizontal Reinforcing – Free-standing CMU Walls:
1. Scope: Free standing, single-wythe CMU walls not serving as a back-up wall for masonry veneers.
 2. Description: Horizontal reinforcing composite:
 - a. Width(es) as required
 3. Base Product: 220 Ladder Mesh by H&B.

2.3 VERTICAL REINFORCING

- A. Reinforcing Bars:
1. ASTM-A615, Grade-60.
 2. Size: 4's minimum, or as otherwise indicated.
 3. Refer to Section 03 20 00, and Drawings.

2.4 MISCELLANEOUS ANCHORAGES

- A. General:
1. Include miscellaneous anchorages as required or indicated, such as those necessary to secure stone/APC copings and sills.
 2. Type:
 - a. As indicated.
 3. Material: Same as indicated for veneer anchors above.

2.5 CAVITY VENTS AND WEEPS

- A. Vent / Weeps:
 - 1. Head Vent:
 - a. Polypropylene honeycomb vent/weep for installation in head joint of brick masonry.
 - b. Provides ventilation of cavity and weeping of cavity moisture while restricting ingress of insects and debris.
 - c. Standard size: 3/8 IN x 2-1/2 IN x 3-3/8 IN.
 - d. Color: Gray.
 - e. Base Product: QV – Quadro-Vent by H&B.
 - 2. Rope Weeps:
 - a. Field cut cotton sash cord, nominal 10mm 3/8 IN.
 - b. Use in combination with Head Vent, where indicated
 - 1) See Part 3 for locations.
- B. Vent / Weeps:
 - 1. Head and Weep Vents:
 - a. Polyvinyl chloride (PVC) vent/weep for installation in head joints of brick masonry.
 - b. Provides ventilation of cavity and weeping of cavity moisture while impeding ingress of insects, debris and rodents.
 - c. Size: 2-1/2 IN.
 - d. Color: Gray.
 - e. Color: White.
 - f. Color: Custom. Match brick mortar.
 - g. Base Product: Brick Vent by Williams-Goodco.

2.6 CAVITY PROTECTION MATERIAL

- A. Non-directional nylon or polyester fiber:
 - 1. Thickness:
 - a. 50 mm 2.0 IN.
 - 2. Height: 250mm 10 IN high.
 - 3. Base Product: Mortar Net.

2.7 MISCELLANEOUS ITEMS

- A. Bond Breaker Strips: Asphalt saturated felt, unperforated; ASTM-D226, Type 1.
- B. Pre-Molded Control Joint Strips at CJ's in CMU walls:
 - 1. Solid rubber strips with a Shore A durometer hardness of 60 to 80.
 - 2. Designed to fit standard sash block and maintain lateral stability in masonry wall.
 - 3. Size and configuration as indicated.
 - 4. Base Product: RS-__ Standard by H&B.
 - a. Exception: Where Sash Blocks are not used: Use RS-8 or RS-12 as appropriate for wall thickness.
 - 5. Use symmetrical design for intermediate control joints, and asymmetrical design (Tee-configuration) where CMU wall abuts or intersects a perpendicular element.
 - 6. Do not bridge CJ's with Horizontal ladder/truss:
 - a. Install 2 smooth dowels or other approved device across Control Joints which resist shear loads but allow in-plane expansion, contraction and linear shrinkage movements.
- C. Galvanizing Repair Paint:
 - 1. High zinc dust content paint for re-galvanizing welds and abrasions in galvanized steel.
 - 2. Base Product: ZRC Galvilite by ZRC Worldwide.
 - 3. Optional: Organic Zinc Coating 90-93 by Tnemec.

-
- D. Compressible Filler:
 - 1. Closed cell neoprene sponge.
 - 2. Thickness: 6mm 1/4 IN.
 - 3. Base Product: NS by H&B.

PART 3 - EXECUTION

3.1 INSTALLATION – GENERAL

- A. Keep vertical joint behind weeps free of mortar.
- B. Comply with provisions of ACI 530 and ACI 530.1, except where exceeded by requirements of the contract documents.

3.2 INSTALLATION – MASONRY WALL ANCHORS

- A. Anchoring CMU Walls to building superstructure or to other intersecting CMU walls:
 - 1. Where masonry walls abut concrete or steel structural elements including shear walls, columns, and spandrel beams, anchor thereto with specialized anchors types indicated.
 - 2. Where bearing walls meet or intersect, erect walls separately and anchor together with rigid steel anchors spaced not more than 610mm 24 IN apart vertically.
 - a. Embed end bends of anchors in cores of masonry units filled with mortar or grout.
 - 3. Where non-bearing walls meet or intersect other walls, erect walls separately and anchor together with wire mesh ties spaced not more than 405mm 16 IN apart vertically.
 - a. Embed ties centered in mortar within joint.
 - 4. Fill solid with mortar or grout masonry unit cells within vertical planes of anchors, or use solid masonry units above and below anchors.

3.3 INSTALLATION – REINFORCING

- A. Immediately before placing, clean reinforcement of substances detrimental to good bond.
- B. Reinforcing at CMU Walls: See Section 04 22 00.

3.4 INSTALLATION OF OTHER ITEMS

- A. Cavity Protection Material:
 - 1. Install per manufacturer's recommendations at ledge angles and bottom of wall.
- B. Galvanizing Repair Paint:
 - 1. Apply wherever galvanized masonry accessories are welded or where the galvanic coating is scratched, abraded or otherwise damaged.
- C. Compressible Filler:
 - 1. Install in the masonry joint below relief angles to preclude mortar from being installed in the joint.
 - 2. Install sealant per Section 07 92 13 in joint to insure water-tightness.

END OF SECTION

SECTION 04 22 00
CONCRETE MASONRY (CMU)

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Concrete Masonry (CMU), as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

- A. Test results performed to qualify materials and establish mix designs.
- B. For NRG units:
 - 1. Certifications: All NRG. Insulated Concrete Masonry Units will meet or exceed ASTM C-90, normal weight classification.
 - 2. Material: All insulated, web-less, concrete masonry units shall be NRG™ ICMU's, (Insulated Concrete Masonry Units) except corner, half, solid bottom bond beam and sash units. These "special" units shall be conventional units and shall interspersed into the NRG™ wall construction where needed. Incorporation of conventional CMU's into the NRG™ wall system will have no significant adverse effect upon thermal performance of the overall system. NRG™ ICMU's are available from manufacturers licensed by Niagara Regional Group, Ltd. ICMU's shall be specified as lightweight, medium weight, or normal weight NRG™ design units. Lightweight and medium-weight are not recommended to be specified for walls that directly contact the building exterior. All units exposed to the building exterior shall contain a manufacturer-approved integral water-repellent CMU admixture at the time of manufacture. The NRG™ ICMU's are available in finishes and colors determined by individual manufacturers. All Masonry Units must contain an integral Expanded Polystyrene Insert installed at the site of production. All Masonry Units must contain a Dovetail design to lock the insulation and inner and outer module together. All Masonry Units must not contain a thermal bridge from face to back where as sound, moisture, and thermal energy can be conducted through the wall.
 - 3. General Conditions: It is important to note that the NRG™ ICMU (Insulated Concrete Masonry Unit) is designed with an off-centered core configuration. Therefore, the vertical rebar (positioned and set in the poured foundation) must be matched to the same off-centered designation. (According to specific size units the position of the vertical rebar will vary.) i.e.: 12" ICMU offset is 2.5". List the requirements for mortar, reinforcing, concrete block work and other associated work and details that relate to this product. If this information is detailed in another section, it should be cross-referenced under this heading. The NRG™ Insulated Wall System is laid similar to any other block, either in a running bond or stacked bond. 10" and 12" NRG units shall be presented to the mason, and the mason shall lay each ICMU with each "cap" on top of the block and facing the same direction. (To insure that the thermal mass of the unit is on the inside, face shell and thumb holes toward the outside exterior of the wall.) 8" NRG units with square cells shall be installed with the blocks in each course "flipped" from the course beneath it.

Note: This will also insure that the wall is laid with the tightest thermal barrier.

Scope: Interior and exterior walls shall be insulated, web-less, concrete masonry units as shown on the plans/ or indicated on the finish schedule.

Fire Resistance: 10" and 12" fire rated for up to 4 hours, 8" will have a 2 hour fire rating. Define hourly ratings required by NCMA TEK Notes.

Field Constructed Mock-ups: Construct a sample panel, no less than 4' x 4', of units of each color and size to be used in the project. (These units need not be NRG™ ICMUs).

A full size unit is required to illustrate color and texture for approval. Manufacturer requires a sample panel be installed at the jobsite prior to installation. This panel will represent both the quality of the product and the workmanship to be expected for the project. The panel must be approved by either the owner or architect for the project. Manufacturer will provide 4" units for a 4' by 4' sample panel at no cost for the material (excluding freight to site).

4. Delivery, storage and handling: Units shall be delivered to the jobsite on covered banded pallets with cardboard between layers. Store pallets in single stacks on level ground and cover with waterproof covering (e.g., tarpaulins) to protect the blocks from inclement weather. Handle blocks carefully to avoid breakage and damage to the finished surfaces.
5. Project/site conditions: Protection of Work: Cover walls each day after installation to keep open walls protected and dry. After units are installed they should be protected from damage by other trades performing operations that can stain or otherwise damage the finished surfaces by covering walls with plastic. Corners should be protected from damage after installation by covering them with plywood.

1.3 SUBMITTALS

A. Project Information:

1. Units to be used in Fire Rated walls: Certification of level of fire-resistance provided by units proposed.

For NRG units, submit color samples for selection from manufacturer. Submit product literature, certifications, test reports and full size sample(s) of each color specified.

1.4 MOCK-UP

- A. Use materials and procedures accepted for the work
- B. Minimum sample panel size is 4 FT square
- C. Acceptable standard for the work is established by the accepted sample panel.
- D. Retain sample panel at the site until the Work has been completed.
- E. Include a grouting demonstration panel if grouting operations planned exceed or vary from the limitations set forth in ACI 530.1-05 - Section 3.5

PART 2 - PRODUCTS

2.1 GENERAL

A. Units to be used in Fire-Resistive wall assemblies:

1. Where units are used in assemblies with Fire-Resistive Rating:
 - a. Provide units with aggregate type, and equivalent thickness that yield fire-resistances indicated for each wall assemblies.

- b. Acceptable calculation methodologies for determining Equivalent Thickness:
 - 1) NCMA TEK 7-1B.
 - 2) ACI 216.1 / TMS 0216.
 - c. Units tested per ASTM E119 are also acceptable.
 - 2. Provide solid units, or grouted hollow units, under lintels.
 - 3. Provide matching concrete bricks as required.
 - 4. Do not use chipped, cracked, spalled units exposed in finish work.
 - 5. Provide reinforced concrete masonry lintels fabricated from precast or site cast load bearing masonry units, filled and reinforced as indicated.
- B. For NRG units:
 - 1. Product name: NRG™ Insulated units are manufactured by quality block producers listed at www.energyefficientblock.com (see NRG producers).
 - 2. Related materials: Colored matching or contrasting mortar is available from manufacturer. Consult NCMA TEK Notes for mortar type and specifications. For all exterior mortar, use matching manufacturer-approved water repellent mortar admixture following manufacturer's instructions. Consult manufacturer for recommendations.
 - 3. Sizes and shapes: Face Sizes: Modular 8"x 16", 4" x 16". Face Mortar Joints: 3/8" exposed.
Shapes not available in the NRG™ design shall be substituted for using conventional hollow core CMU's matching the same finish and color of the NRG™ units. These conventional blocks shall also contain an integral water repellent when exposed to the building exterior.
 - 4. Scoring of the face shall be accomplished through the molding process, or by cutting 3/8" wide x 1/4" deep grooves into the face of the ICMU's or CMU's These grooves shall be pointed and tooled using the same mortar as used to lay the units. *When center scored units are used, the finished wall will be much neater to lay if stack bond is used. The use of scored units which have bonding patterns that do not require continuous vertical joints can be installed faster and more economically.
 - 5. *Exterior mortar joints should be raked back a minimum of 1/4" and tuck pointed with an approved water resistant grout.
 - 6. Face joints shall be 3/8" wide and the block joints on the sides, top and bottom shall be 3/8" wide, (thereby giving the visual effect of 8" x 8" squares)
Miscellaneous Tools and Products Required by Masons: Contractor shall include products such as mortar, reinforcing, ties, anchors, and other masonry attachments as may be required to properly finish the project. Striking or jointing tools, rags, and masonry cleaners shall also be required.
 - 7. Masonry cleaners: Carefully following manufacturer's instructions, use Burnished Custom Masonry Cleaner by PROSOCO (dilute 1 part to 3 parts clean water). Available from manufacturer. **Do not powerwash.**
CAUTION! Never use Muriatic Acid solution or any cleaner with an acid base on units.

2.2 CONCRETE MASONRY UNITS - GENERAL PURPOSE

- A. Concrete Masonry Units (CMU):
 - 1. Modular units complying with ASTM C90.
 - 2. Aggregate:
 - a. Normal Weight: In accordance with ASTM C33.
 - 3. Sizes and shapes as indicated or required for conditions.
 - 4. Face shell and web thickness: Table 3, ASTM C90.
- B. Corner Units:
 - 1. Exposed to view: Use bullnosed units at external corners and jambs of openings.

2. Not Exposed to view: Square-nosed units may be used where corners will not be visible in completed wall.

2.3 CONCRETE LINTELS AND SILLS

- A. General:
 1. Fabricate concrete lintels and sills in plant or site cast.
 2. Use concrete having minimum 28 day compressive strength of 21 MPa 3000 PSI.
 3. Exposed surfaces to have surface texture and color to match adjacent concrete masonry units.
 4. Fabricate lintels to modular sizes to match coursing.
 5. Mark tops of lintels with lintel schedule number.
- B. Fabricate lintels by one of following methods:
 1. Use masonry lintel units and reinforced concrete fill.
 2. Cast lintels monolithically with reinforcement.
 3. Provide vertical dummy joints matching pattern of vertical joints and scoring in concrete masonry walls in which installed.

2.4 REINFORCING

- A. Horizontal Reinforcing products including wire ladder truss: Specified in Section 04 05 23.
- B. Reinforcing Bars (vertical and horizontal): Specified in Section 03 20 00.

2.5 ACCESSORY ITEMS

- A. Masonry accessories: See Section 04 05 23.
- B. Mortar and grout: See Section 04 05 13.
- C. Firestopping: See Section 07 84 00 for rated wall penetrations.
- D. Sealants: See Section 07 92 13 and Section 07 92 16 for non-rated wall penetrations.
- E. Grout fill: As specified in Section 04 05 13.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Verify suitability of substrate to accept work.
- B. Verify that anchors and flashings are correct.
- C. Installation constitutes acceptance of substrate and responsibility for performance.

3.2 INSTALLATION

- A. General:
 1. Comply with provisions of ACI 530 and ACI 530.1, except where exceeded by requirements of the contract documents.
 2. Perform cutting with masonry saws.
 3. Cut as required to provide pattern indicated.
 4. Use solid units where cutting or laying would expose holes.
 5. Do not install damaged units.
 6. Do not wet concrete masonry units.
 7. Avoid use of less than half size units.
 8. Build chases and recesses as indicated and required for work of other trades.

- B. Install in running bond unless otherwise indicated.
- C. For NRG units:
1. Lighting: Provide adequate lighting for masonry work by placing all lighting at a reasonable distance from the wall for even illumination. Do not use trough lighting.
 2. Cutting: All cuts for bonding, boxes, holes, etc. shall be made using a motor driven masonry saw using either an abrasive or diamond blade.
Note: The NRG unit should not be cut in half.
 3. Mortar, bedding and jointing: Lay units with full mortar coverage on head and bed joints taking care not to block cores to be grouted or filled with masonry insulation. Tool all mortar joints when thumbprint hard into a concave configuration. Care should be taken to remove mortar from the face of masonry units before it sets. Tuckpoint the joints of scored units for proper appearance. All exterior scored units must be tuckpointed to prevent water penetration. **No rake joints.**
 4. Flashing of masonry work: Install flashing at locations shown in the plans and in strict accordance with the details and the best masonry flashing practices.
 5. Weep holes and vents: The bottom 2" of the vertical joints shall be left open in every other block unit in the first course above grade. Such open joints shall also be left open above flashing, beam units, and filled block areas that act as water stops. Consult NCMA TEK Notes for proper flashing and drawings.
 6. Inspection: The faces shall conform to the requirements of ASTM C90 when viewed from a distance of twenty (20) feet at right angles to the wall with normal lighting.
 7. Cleaning: Keep walls clean daily during installation using brushes, rags and the burlap squares supplied on the pallets. Do not allow excess mortar lumps or smears to harden on the finished surfaces. Harsh cleaning methods after walls have been erected will mar the surface of the blocks.
 8. Final cleandown: Clean the completed walls with PROSOCO Burnished Custom Masonry Cleaner (dilute 1 part to 3 parts clean water), strictly following the manufacturer's instructions – including thorough rinsing. Do not use acid or abrasives on the finished surfaces. Failure to strictly follow manufacturer's instructions can result in permanent damage to the finished faces. Do not apply Burnished Custom Masonry Cleaner with pressure spray above 50 psi. **Do not powerwash.**
 9. Field coat application: Apply to walls after cleandown and when the walls are dry. Apply the acrylic evenly to cover the entire surface without forming drips or runs. For maximum coverage and best appearance, apply with airless spray equipment. Consult manufacturer for further information.
 10. Maintenance: Properly installed and cleaned, units need virtually no maintenance other than routine cleaning (i.e. Pinesol or Fantastik). Graffiti, paint or dye stains may need special cleaning methods and products. Contact manufacturer for specific cleaning recommendations.
 11. Installation recommendations: Consult NCMA TEK Notes, for proper installation of concrete masonry units.

3.3 PARTITION IDENTIFICATION

- A. Identify partitions indicated on Drawings as having a required fire or smoke rating.
1. Follow guidelines set in Chapter 7 of International Building Code.
 2. Permanently identify with signs or stenciling with contrasting, 3 inch high letters in a manner acceptable to authority having jurisdiction.
 3. Suggested text for fire and smoke barriers: FIRE AND SMOKE BARRIER – PROTECT ALL OPENINGS.

3.4 LAYING AND TOOLING

- A. Lay out walls in advance for uniform and accurate spacing of bond patterns and joints.

- B. Properly locate openings, movement joints and offsets.
- C. Lay masonry units with face shells of bed joints fully mortared.
 - 1. Webs shall be fully mortared in all courses of piers, columns, and pilasters, in the starting course on foundations and when necessary to confine grout or loose filled insulation.
 - 2. Head joints shall be mortared a minimum distance from each face equal to the face shell thickness.
 - 3. Vertical cells to be grouted shall be aligned and unobstructed openings.
- D. Maintain nominal 3/8 IN joint widths.
 - 1. Cut joints flush where concealed.
 - 2. Tool exposed joints.
 - 3. Compress mortar in below ground joints.
- E. During tooling of joints, enlarge voids or holes, except weep holes, and completely fill with mortar.
- F. Point up joints at corners, openings and adjacent work to provide neat, uniform appearance.
- G. Remove masonry disturbed after laying.
 - 1. Clean and relay in fresh mortar.
 - 2. Do not pound units to fit.
 - 3. If adjustments are required, remove units, clean, and reset in fresh mortar.
- H. Where work is stopped and later resumed, rake back 0.5 masonry unit length in each course; do not tooth.
 - 1. Remove loose units and mortar prior to laying fresh masonry.
- I. Protect against weather, when work is not in progress.
 - 1. Cover top of walls with waterproof membrane, extend at least 4 FT down both sides of walls; anchor in place.
 - 2. Provide cold weather protection; Section 04 05 05.
- J. As work progresses, build in items indicated and specified.
 - 1. Fill in solidly with mortar around built-in items.
 - 2. Grout fill space between metal frames and masonry.
 - 3. Where built-in items are to be embedded in cores of hollow masonry units, place layer of metal lath in joint below and fill core with grout.
- K. Remove masonry protrusions extending 1/2 IN or more into cells or cavities to be grouted.
- L. For NRG units:
 - 1. Workmanship: ICMU's shall be laid with the faces level, plumb, and true to a line strung horizontally at the face. Units shall have uniform joint dimensions 1/4" both horizontal and vertical. Joints shall be tooled, straight and inform neatly after they are finger hard. Cut pieces shall be sized and placed appropriately to maintain consistency and bond. Masonry construction shall be completed using procedures and workmanship consistent with the best masonry practices.
 - 2. Control Joints: Control joints shall be installed in the locations designated in design plans.
 - 3. Coping: As shown in details/ or specified.

4. Draw blocks from more than one pallet at a time during installation. All exterior mortar shall include manufacturer-approved matching water-repellent additive added to each batch in the appropriate dosage rates for mortar type (M, S or N) per manufacturer's instructions. Refer to NCMA TEK Notes, for Hot and Cold weather construction practices. Lay units using the best concrete masonry practices. Install only quality units; reject all defective units as defined by ASTM C90.
Lay blocks with the faces level, plumb and true to the line strung horizontally at the ground or filled and polished face. Units shall have uniform, 3/8"-wide joints both horizontally and vertically on the finished side of the wall. Tool joints neatly after they are finger-hard to make them straight and uniform. Size and place cut pieces appropriately to maintain consistency and bond. Complete masonry construction using procedures and workmanship consistent with the best masonry practices.

3.5 REINFORCING

A. General:

1. In addition to the following general requirements, provide reinforcing size type and spacing as indicated on Drawings and Details.

B. General Reinforcing Requirements:

1. Reinforce masonry openings over 12 IN wide, where control and expansion joints are not provided, with horizontal joint reinforcing placed in 2 horizontal joints above lintel and below sill.
 - a. Extend reinforcing minimum of 24 IN beyond jambs of opening.
2. Embed horizontal reinforcing in bed joint mortar for entire length with minimum cover of 5/8 IN on exterior side of walls and 1/2 IN at other locations.
 - a. Provide same minimum cover for other embedded items.
3. Minimum laps for horizontal reinforcing: 6 IN.
4. Do not bridge Control Joints or Expansion Joints with horizontal reinforcing.
 - a. Install smooth dowels or other approved device across Control Joints which resist shear loads but allow in-plane expansion, contraction and linear shrinkage movements.

C. Horizontal Reinforcing (wire ladders/trusses):

1. Provide continuous horizontal joint reinforcing concrete masonry walls.
 - a. See elsewhere for reinforcing requirements for anchored veneers.
2. Unless otherwise indicated:
 - a. Install horizontal reinforcing with in 8 IN of first bed joint.
 - b. Running Bonds: Install horizontal reinforcing at 16 IN OC vertically thereafter.
 - c. Stacked Bonds: Install reinforcing 8 IN OC vertically thereafter where stack bond masonry is indicated.
3. Make corners and wall intersections by use of prefabricated L and T sections.
 - a. Cut and bend as required.
4. At intersecting load bearing walls install rigid steel anchors not over 24 IN OC vertically.
 - a. Embed ends in grout filled cores.

D. Horizontal Reinforcing Bars:

1. Install where indicated.
2. Sizes as indicated.

E. Vertical Reinforcing Bars at CMU Walls other than Anchored Veneers:

1. Install vertical reinforcing bars as indicated.
2. When not indicated, provide the following minimum vertical reinforcing:
 - a. Provide one No.5 continuous at 48 IN on center.
 - b. Provide one No.5 Continuous at each corner, at each side of each opening, at each side of each control joint, and at the ends of walls.

3.6 GROUT FILL

- A. Do not place grout until entire portion of wall to be grouted has attained sufficient strength to resist grout pressure.
- B. Use mechanical means to remove air pockets and void for proper consolidation of fill.
- C. Grout walls incrementally as CMU is placed. Minimize lift heights to ensure that walls will remain safe and stable until grout has attained sufficient strength to resist overturning or collapse.
 - 1. Consider detrimental lateral loads which could be anticipated including storms, winds, seismic, soil etc.
 - 2. Adequately brace as needed.
- D. Where vertical or horizontal reinforcing bars are required, place and inspect prior to filling operation.
- E. Fill cores containing vertical reinforcing.
- F. Place in maximum 4 FT lifts.
- G. Leave lifts minimum 1-1/2 IN below top of course to form key with next lift.

3.7 CONTROL JOINTS (CJ)

- A. Provide Control Joints (and other movement joints) as indicated.
- B. Where not indicated:
 - 1. Locate CJ's at natural planes of weakness in masonry wall such as:
 - a. Changes in wall height.
 - b. Changes in wall thickness, such as at pipe and duct chases and pilasters.
 - c. At (above) movement joints in foundations and floors on which wall is bearing.
 - d. At (above) movement joints in roofs and floors that bear on wall.
 - e. Openings: Within 8 IN of one or both jambs of door, window, louver and similar openings:
 - 1) Place CJ at one side of openings less than 6 FT wide.
 - 2) Place CJ at both sides of openings greater than 6 FT wide.
 - f. Corners: Within 4 FT of corners (on at least one leg).
 - 1) Opposing leg: No more than 20 FT from corner.
 - g. Intersections: Within 12 FT of wall intersections.
 - 2. In addition to of the above, locate CJ's at no more than the following absolute maximum (horizontal) distances:
 - a. Walls less than 5 M 16 FT-8 IN tall: Not more than 1-1/2 times the wall height.
 - b. Walls greater than 5 M 16 FT-8 IN tall: No more than 7.62 M 25 FT O.C.
- C. Installation/construction of CJ's:
 - 1. Utilize sash blocks or similar shapes which have slotted end to accept gaskets.
 - a. Pre-molded Control Joint Strips: Specified in Section 04 05 23.
 - 2. Cut ladder/truss type horizontal reinforcing as it crosses CJ's.
 - 3. While mortar is still fresh, rake out mortar from joint, leaving a completely clean joint.
 - 4. After wall has cured, install backer rod and sealant on both wall faces.
 - a. Sealant and Backer Rod: Specified in Section 07 92 13 and Section 07 92 16.

3.8 LINTELS, FLASHING AND SEALANTS

- A. Installation of flashing, weeps and similar masonry accessories: Specified in Section 04 05 23.
- B. Sealant installation requirements:

1. Sealant and Backer Rod: Specified in Section 07 92 13 and Section 07 92 16.
 2. Remove mortar in joint under relieving lintel and at ends.
 3. Seal joints between CMU's and relieving lintels.
 4. Seal Expansion and Control Joints.
- C. Provide precast masonry lintels wherever openings more than 12 IN wide are indicated without other structural support or other supporting lintels.
1. Thoroughly cure lintels before handling and installation.
 2. See lintel schedule for size and type required.

3.9 INSTALLATION TOLERANCES

- A. Maximum variation from plumb in vertical lines and surfaces of columns, walls and arises:
1. 1/4 IN in 10 FT.
 2. 3/8 IN in a story height not over 20 FT.
 3. 1/2 IN in 40 FT or more.
- B. Maximum variation from plumb for external corners, control joints, expansion joints and other conspicuous lines:
1. 1/4 IN in any story or 20 FT maximum.
 2. 1/2 IN in 12 m FT or more.
- C. Maximum variation from level of grades for exposed lintels, sills, parapets, horizontal grooves and other conspicuous lines:
1. 1/4 IN in any bay or 20 FT.
 2. 1/2 IN in 40 FT or more.
- D. Maximum variation from plan location of related portions of columns, walls and partitions:
1. 1/2 IN in any bay or 20 FT.
 2. 3/4 IN in 40 FT or more.
- E. Maximum variation in cross section of columns and thicknesses of walls from dimensions indicated:
1. Minus 1/4 IN.
 2. Plus 1/2 IN.

3.10 REPAIR, POINTING AND CLEANING

- A. Remove and replace loose, stained, or damaged units.
1. Provide new units to match.
 2. Install in fresh mortar.
 3. Point to eliminate evidence of replacement.
- B. Clean in accordance with Section 04 05 10.

3.11 INSPECTION AND TESTING

- A. Permit and facilitate access to the construction sites and the performance of activities for quality assurance by the testing and inspection agencies.
- B. Comply with the requirements of ACI 530.1 Section 1.6C and facilitate the testing and inspection agencies needs.
- C. The Owner will provide testing and inspection services. This does not relieve the contractor of the responsibility to furnish materials and construction in full compliance of contract documents.

END OF SECTION

HDR
RNL No. 3557-02
HDR No. 0133-200573

04 22 00 - 10
CONCRETE MASONRY (CMU)

Kansas City Downtown Streetcar
KCMO Contract No. 89022000-004

**SECTION 05 05 05
GALVANIC CORROSION PROTECTION**

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish all labor, materials, tools, equipment, and services for Galvanic Corrosion Protection, as indicated, in accordance with provisions of Contract Documents.
- B. Use information in this Section to coordinate, select and apply products listed in other Sections for purposes of Galvanic Corrosion Protection.
- C. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

- A. Provide galvanic corrosion protection:
 1. Appendix C, SMACNA Sheet Metal Manual –6th. Edition.
 2. ASTM G82 and ASTM STP576.

1.3 GALVANIC CORROSION POTENTIAL

- A. Galvanic Scale: Less Noble, electropositive or anodic metals which corrode more readily are at top of scale. Those that are more electronegative or cathodic, Noble, are at bottom of scale.

GALVANIC SCALE
Anodic / Corroded End / Less Noble Materials
Zinc
Aluminum
Galvanized Steel
Cadmium
Mild Steel / Wrought Iron
Cast Iron
Stainless Steel, Types 304 & 316 (active)
Lead-tin Solder
Lead
Brass / Bronze
Copper
Stainless Steel, Types 304 & 316 (Passive)
Cathodic / Protected End / Noble Materials

PART 2 - PRODUCTS – NOT USED**PART 3 - EXECUTION****3.1 INSTALLATION**

- A. Avoid contact between metals that are farther apart in the scale.
- B. Do not couple a small exposed area of a less noble material with a large area of a more noble material.
- C. Coat noble metal with a suitable paint or other non-metallic coating or coat both surfaces at their interface with zinc chromate or bituminous coating.
- D. Separate the metals by tape, gasket, waterproof paper, elastomeric sheet, sealant or other non-absorptive, non-conductive material.
- E. Do not allow moisture run-off from noble material to drain onto less noble material.
- F. Do not use copper nails for fastening galvanized steel roof panels .
- G. Do not use galvanized steel nails on copper roofing.
- H. Do not use galvanized bolts, nuts or washers on stainless steel components.

3.2 METALS EMBEDDED IN CONCRETE

- A. Hot-dip galvanized with bituminous paint.
 - 1. Use at exterior and interior areas exposed to weather or high humidity.
- B. Non-galvanized steel with bituminous paint:
 - 1. Use at interior areas with low or ordinary humidity.
 - 2. Avoid direct embedment where exposed to weather or high humidity.

PART 4 - MEASUREMENT

4.1 Measurement – No Separate measurement will be made for Work described in this Section.

PART 5 - PAYMENT

5.1 Payment – Payment for items in this Section will be incidental to the Contract unit cost of the metal bid items.

END OF SECTION

SECTION 05 12 00**STRUCTURAL STEEL FRAMING****PART I - GENERAL****1.1 SUMMARY****A. Description**

This Work includes furnishing, fabrication and installation of structural steel, other than bridges, as shown on the Contract Drawings and as specified herein. The work includes the furnishing of labor, material, equipment to procure, fabrication, painting, transport, erect and install steel bridges. The work also includes base plates, shear stud connectors, expansion joint plates and all accessories required for a complete installation.

1.2 REFERENCES

<u>Sponsor</u>	<u>Number</u>	<u>Subject</u>
AASHTO		Standard Specifications for Highway Bridges
AISC		Manual of Steel Construction, Allowable Stress Design
AREMA		Manual for Railway Engineering
ASTM	A36	Specification for Carbon Structural Steel
ASTM	A 53	Specification for Steel Pipe, Black and Hot-Dipped, Zinc-Coated; Welded and Seamless
ASTM	A 123	Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM	A 325	Specification for High Strength Bolts for Structural Steel Joints
ASTM	A 490	Specification for High Strength Bolts for Structural Steel Joints
ASTM	A 500	Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM	A 501	Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing
ASTM	A 563	Specification for Carbon and Alloy Steel Nuts
ASTM	A 588	Specification for Atmospheric Corrosion Resistant High-Strength Low-Alloy Structural Steels
ASTM	A 709	Specification for Carbon and High-Strength Low-Alloy Structural Steel Shapes, Plates, and Bars and Quenched-and-Tempered Alloy Structural Steel Plates for Bridges
ASTM	F 436	Specification for Hardened Steel Washers
ASTM	F 844	Specification for Washers, Steel, Plain (Flat), Unhardened for General Use

AWS	D1.1	Structural Welding Code - Steel
AWS	D1.5	Bridge Welding Code

1.3 SUBMITTALS

- A. Submittals shall be made in accordance with the requirements of the Project Quality Plan, except as modified herein.
- B. Product Data: Technical data and installation instructions including laboratory test reports and supporting data to show compliance with specifications.
 - 1. Structural steel (each type), including certified copies of mill reports covering chemical and physical properties.
 - 2. High strength bolts (each type), including nuts and washers (direct tension indicators, if used).
 - 3. Structural steel primer paint.
- C. Method Statement including welding procedure, welders qualifications, fabrication, painting/galvanization, erection procedures/schedule, maintaining of yard operation and protection of passing trains shall be submitted.
- D. Nondestructive weld test reports shall be submitted within 5 days of the performance of the tests.
- E. Mill test reports signed by manufacturers certifying specified products comply with requirements. Indicate structural strength, destructive and nondestructive test and analysis.
 - 1. Structural steel, including chemical and physical properties.
 - 2. Bolts, nuts and washers, including mechanical properties and chemical analysis.
 - 3. Direct tension indicators.
 - 4. Shear stud connectors
 - 5. Shop primers.
- F. Shop Drawings shall be prepared under supervision of and signed and sealed by qualified licensed professional engineer, including complete details and schedules for fabrication and assembly of structural steel members, procedures, and diagrams.
 - 1. Indicate details of cuts, connections, splices, camber, holes, and other pertinent data.
 - 2. Indicated welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld.
 - 3. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify high strength bolted slip critical, direct tension, or tensioned shear/bearing connections.

4. Provides setting drawings, templates, and directions for installation of anchor bolts and other anchorages to be installed as work of others.
- G. Copies of each survey conducted, showing elevations and locations base plates and anchor bolts to receive structural steel and final elevations and locations for major members. Indicate discrepancies between actual installation and contract documents.

1.4 QUALITY CONTROL

- A. Quality control shall meet the requirements of the Project Quality Plan, except as modified herein.
- B. Fabrication shall be in accordance with the requirements of the AREMA Chapter 15, Part 3, the AISC and ASTM manuals and standards referenced herein and as specified. Welding procedures and welders shall be qualified in accordance with requirements of AWS D1.1 and D1.5.
- C. The Contractor or steel fabricator shall engage a qualified licensed professional engineer to prepare calculations, shop drawings, and other structural data for steel connections.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Deliver structural steel to site in quantities and at times ensuring continuity of installation.
- B. Materials shall be delivered clearly identified, marked, and match marked as necessary for erection. Match markings shall conform to those marks shown on the approved shop drawings.
- C. Store materials to permit easy access for inspection and identification. Keep steel members off of the ground using pallets, platforms, or other supports. Protect steel members and packaged materials from erosion and deterioration.
 1. Store fasteners in a protected place. Clean and re-lubricate bolts and nuts that become dry or rusty before use.
 2. Do not store materials on structure in a manner that might cause distortion or damage to members or supporting structures. Repair or replace damaged materials or structures as directed by the Engineer.

PART II - PRODUCTS

2.1 MATERIALS

- A. Materials shall conform to the following requirements:
 1. Structural plates, shapes, and bars: ASTM A 588, ASTM A 709 and ASTM A36
 2. Nuts: ASTM A 563, Heavy Hex; Washers: ASTM F 436, Grade 3
 3. High Strength Bolts: ASTM A 325, Type 3 or ASTM A490, Type 3
 4. Welding Electrodes: AWS D1.1
 6. Structural Steel Pipe: ASTM A 53 Grade B

2.2 FABRICATION

- A. Fabricate and assemble structural steel in shop to the greatest extent possible. Fabricate structural steel according to referenced specifications and in Shop Drawings. Architecturally exposed structural steel shall be in accordance with section 05 12 13.
1. Dimensions of members and pieces shall be modified as required to compensate for weld shrinkage, distortion, elastic deformation, camber, sweep, slope, waste for proper machining and oxygen cutting, and other material alterations that may make initial in-process fabricating dimensions and material ordering dimensions different than the final product design dimensions shown on the Contract Drawings.
 2. After obtaining approval of shop and erection drawings, all members and plates shall be fabricated to the design dimensions shown on the plans in accordance with the applicable requirements of the AISC Manual and Code, and as specified herein.
 3. Joint contact surfaces and areas adjacent to bolt holes shall be free of all scale (except tight mill scale), burrs, dirt, paint, and other foreign material that may prevent solid seating of the parts.
 4. Galvanize as shown on the Contract Drawings or as specified in Section 05 50 00 Metal Fabrications. Steel shall be galvanized in such a manner so that the paint will bond.
 5. Painting surfaces of metal in contact with each other when assembled shall only be painted as allowed by AISC specifications. Complete assemblies, including welding of the units, before starting shop priming operations.
 6. Members shall be free from twists, bends or other deformations. Measurements shall be checked before drilling or reaming holes to ensure that the assembly conforms to the dimensions shown on approved shop drawings within the dimensional tolerances specified.
 7. Accurately mill ends of columns and other members transmitting loads in bearing.
 8. Unless shown otherwise, comply with AISC Manual of Steel Construction for framed or seated connections. Unless larger reactions are indicated on the plans, connections shall be designed for at least one-half of the total uniform load capacity tabulated in the tables of the manual for the given shape and span of the beam in question. A minimum length of framed connection shall be provided equal to one-half of the "T" distance of the beam web.
 9. Match-marks shall be provided on connecting parts assembled and drilled for field connections.
 10. Prepare steel surfaces as recommended by the manufacturer of shear connectors. Use automatic end welding of headed stud shear connectors according to AWS D 1.1 and manufacturer's printed instructions.
- B. Shop Connections
1. Structural steel shall be welded in accordance with AWS D1.1 and AWS D1.5.
 3. Welding electrodes and fluxes shall be stored and controlled in accordance with procedures recommended by the welding electrode manufacturer.

3. Groove joints shall be prepared for field welding. Such joints shall be assembled in the shop, considering correct camber, to ensure proper joint alignment and fit.
 4. Shop install and tighten high strength bolts according to RCSC's Specification for Structural Joints Using ASTM A 325 or A 490 Bolts.
 5. Assemble and weld built-up sections by methods that maintain true alignment of axes without warp.
- C. Holes: Provide holes required for securing other work to structural steel framing and for passage or other work through steel framing members shown on the Shop Drawings.
1. Cut, drill, or punch holes perpendicular to metal surfaces. Do not flame cut holes or enlarge holes by burning. Drill holes in bearing plates.
 2. Weld threaded nuts to framing and other specialty items as indicated to receive other work.

2.3 SHOP PRIME COAT PAINTING

- A. Clean and shop prime coat all shop fabricated structural steel before delivering to the site. Prepare surfaces and perform painting in accordance with SSPC specifications.
- B. Shop prime steel surfaces, except the followings:
1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches.
 2. Field welded surfaces.
 3. High strength bolted surfaces with slip critical connections.
 4. Sprayed on fireproofing surfaces.
 5. Galvanized surfaces.

2.4 SOURCE QUALITY CONTROL

- A. General
1. Materials shall conform to the designated ASTM requirements, and welding electrodes conform to the AWS requirements.
 2. Welding equipment shall be inspected to ensure that it conforms to the applicable codes or specifications. The size, length, location and quality of all welds shall be examined visually. All non-destructive testing shall be performed by an independent third party that is pre-approved by the Engineer prior to the commencement of the welding work. The Engineer may choose to witness the non-destructive tests. Records of the test reports shall be prepared, maintained, and submitted to the Engineer.
 3. The installation and tightening of bolts shall be to the specified requirements. An inspecting torque wrench shall be used for arbitration of disputes concerning bolt tension in the turn-of-nut method of installation.

4. Fabricated and assembled members shall meet the dimensional tolerances and permitted deviations.
 5. Surface preparation and primer application shall be in compliance with these specifications.
 6. Each fabricated and inspected piece shall be marked, by paint or ink stamp, with the inspector's acceptance mark.
- B. Inspection and Non-Destructive Testing of Welded Joints
1. The following examination methods shall be used as and where specified. The required examinations shall be shown on the Shop Drawings. The following list is in descending order of rank. When a particular examination method is specified for a joint and the method is impracticable to use, the highest order method that is practicable shall be used. The alternative method will be subject to approval.
 - a. Radiographic Method
 - b. Ultrasonic Method
 - c. Magnetic Particle Method
 2. Requirements for Ten Percent Examination
 - a. A 12" section of weld shall be examined in each 10' increment of each welder's work. If the examination meets the acceptance standards of AWS D1.1 or D1.5, the 10' of weld represented will be accepted.
 - b. If the examination fails to meet the acceptance standards of AWS D1.1 or D1.5, two additional 12" sections shall be examined in the 10' increment. If both of these examinations meet the acceptance standards, the 10' weld represented will be accepted. The defects detected in the first examination shall be repaired and the work shall be re-examined.
 - c. If one or both of the examinations fail to meet the acceptance standards of AWS D1.1 or D1.5, the remaining weld of the 10' increment shall be examined. The areas that do not meet the acceptance standards shall be repaired and the work shall be re-examined.
- C. Replacement of Defective Welds
1. Welds found to contain defects that are prohibited by AWS D1.1 or D1.5 shall be replaced or repaired by methods permitted by AWS D1.1 or D1.5. Repaired and replaced welds shall be re-examined by the same method and acceptance standard used to examine the original defective weld.
 2. In addition to the above, when welds are found to contain prohibited defects, the cause of the defective welding shall be determined and immediate corrective action shall be taken. Shop inspectors shall be required to check and verify that corrective actions are instituted and carried out.

PART III - EXECUTION

3.1 ERECTION EXAMINATION

- A. The Contractor shall verify, by dimensional check, that all support areas are complete and correct in size, location and elevation within tolerances allowed by AISC specifications and code.
- B. The Contractor shall verify, by dimensional check, that all embedded anchor bolts at supports are correct in diameter, location and projection within tolerances allowed by AISC specifications and code.

3.2 FIELD ERECTION

- A. All steel shall be erected in accordance with the erection sequence stated on the approved erection Shop Drawings.
- B. Field welds shall conform to the requirements for shop welding and shall be placed only where indicated on the approved Shop Drawings.
- C. The Contractor shall verify by measurement that the final alignment and profile of the erected steel conforms to the requirements of the plans.

3.3 FIELD QUALITY CONTROL

- A. The Contractor shall comply with the inspection requirements as defined in the Project Quality Plan.

PART IV - MEASUREMENT

- 4.1 Measurement** – No Separate measurement will be made for Work described in this Section.

PART V - PAYMENT

- 5.1 Payment** – Payment for items in this Section will be incidental to the Contract unit cost of the metal bid items.

END OF SECTION

SECTION 05 12 10
STRUCTURAL STEEL**PART 1 - GENERAL****1.1 SUMMARY**

- A. Furnish all labor, materials, tools, equipment, and services for Structural Steel, as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

- A. Structural steel work covered herein shall be fabrication and erection of steel framing and bracing members including connections and steel material either supporting or connected to steel members shown on structural plans and not specified in other sections.
- B. Quality standards latest edition of the following standards plus any corresponding published revisions at the time of bidding shall be the applicable standard. The Local Building Code shall govern when conflicts occur.
 - 1. Local Building Code.
 - 2. American Institute of Steel Construction (AISC):
 - a. ANSI/AISC 360 "Specification for Structural Steel Buildings" (referred to herein as the AISC Specification).
 - b. Code of Standard Practice for Steel Buildings and Bridges (referred to as AISC Code of Standard Practice).
 - c. Quality Certification Program.
 - 3. American Welding Society:
 - a. Structural Welding Code - Steel ANSI/AWS-D1.1 (referred to herein as the AWS Code). The AWS Code shall govern the techniques and quality of welding and testing procedures. Statements contained in the AWS Code requiring information to Bidders and/or Contract Documents to define nondestructive testing or statements defining responsibilities and obligations for services and payment shall be disregarded.
 - 4. Research Council on Structural Connections: "Specifications for Structural Joints Using High Strength Bolts" (referred to herein as the RCSC Specification).
 - 5. Steel Structures Painting Council (SSPC): Steel Structures Painting Manual Vol. 2, "System and Specifications" (referred to herein as the SSPC Specification).
- C. Qualifications:
 - 1. Steel fabricator:
 - a. Certified by AISC Quality Certification Program for Structural Steel Fabricators and is designated as AISC Certified Fabricator, Standard for Steel Building Structures.
 - b. Fabricators not certified shall have minimum 10 years experience and shall employ an approved testing agency to inspect fabrication work performed off site. The testing agency shall furnish weekly inspection reports and a final report to the Building Official and the Architect certifying the work was performed in accordance with the specifications and approved shop drawings.
 - 2. Steel erector:
 - a. Minimum 10 years experience in erection of structural steel.
 - b. Certified as Certified Steel Erector by AISC quality Certification Program.
 - 3. Certification by other equivalent programs subject to approval of the Structural Engineer.

- D. Source quality control:
 - 1. Provide access and facilities for testing agency during shop and field inspections.
- E. Testing and inspection: Employ and pay for services of an independent testing agency acceptable to Architect, to inspect structural steel work for compliance with specifications, and perform following:
 - 1. Inspect quality of base material.
 - 2. Inspect shop fabricated structural steel members.
 - 3. Inspect shop and field welding in accordance with Section 6 of AWS Code, including qualification tests of welders and following non-destructive testing.
 - a. Test 20 percent of fillet welds with liquid dye penetrate.
 - b. Test 100 percent of full penetration welds with ultrasonic or radiographic testing.
 - 4. Inspect high strength bolting in accordance with Section 6 of Specification for Structural Joints.
 - 5. Inspect structural steel during erection.
 - 6. Inspect stud welding in accordance with AWS Code.
 - 7. Inspect shop painting.
 - 8. Prepare and submit test reports to Architect. Cooperate with Architect to determine corrective measures necessary for defective work.
 - 9. Upon completion certify that fabrication and erection comply with Contract Documents.
- F. Provide testing and inspection agency with sufficient notification and access so that inspection and testing can be accomplished.
- G. Previous acceptance of material or finished members by testing and inspection agency or Architect/Engineer shall not prevent its rejection at later date if it does not comply with specifications.
- H. Tolerances:
 - 1. Rolling: ASTM-A6.
 - 2. Fabrication and Erection tolerances: AISC Code of Standard Practice.
- I. Complete final design of connections not defined on Contract Documents.
 - 1. Design connections at each end of member for loads (in Kips) noted in parenthesis. If load not indicated, design for capacity of member.
 - 2. Connection arrangement and detail shall be consistent with similar connections where indicated on Contract Documents.
 - 3. Connection design shall satisfy applicable Building Codes and shall use latest approach to design as offered by AISC.

1.3 SUBMITTALS

- A. Shop Drawings:
 - 1. Indicate details including cuts, copes, connections, holes and welds. Indicate shop and field welds using AWS symbols. Indicate connections where high strength bolts are required.
 - 2. Headed stud placement drawings.
- B. Product Data:
 - 1. Source and certification of quality for high-strength bolts, nuts and washers.
 - 2. Technical data on base plate grout.
- C. Project Information:
 - 1. Fabricator's AISC Certification or name of independent testing agency for use by non-certified fabricator along with proof that fabricator has 10 years experience in fabrication of structural steel for buildings.
 - 2. Inspection reports and certification of shop fabrication by independent testing laboratory for non-certified fabricator.
 - 3. Steel erector's AISC Certification and proof that steel erector has 10 years experience in erection of structural steel.

4. Welding Procedure Specification (WPS) for shop and field welds.
- D. Contract closeout information:
1. Certificate by fabricator that steel was fabricated in accordance with the approved construction documents.
 2. Certificate by erector that steel was erected in accordance with the approved erection plans and specifications.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Steel, structural "W" shapes and tee's: ASTM A992 (50 ksi yield point).
- B. Other steel shapes and plate: ASTM A36.
- C. Pipe round: ASTM A53, Grade-B.
- D. Tubing square or rectangular: ASTM A500, Grade-B (317 MPa 46 KSI minimum).
- E. Bolts, nuts, and washers, high-strength. Conform to RCSC Specification
1. Twist off style, conform to ASTM F1852
 - a. Approved bolts:
 - 1) Tension control bolt by LeJeune Bolt Company, Burnsville, MN.
 - 2) Tru-Tension Fasteners by Nucor Fastener a Division of Nucor Corporation, St. Joe, Indiana.
 - 3) Lohr Fasteners by Lohr Structural Fasteners, Humble, TX.
- F. Bolts, nuts and washers, standard strength:
1. Bolts: ASTM A307, Type A.
 2. Nuts: ASTM A563.
 3. Washers plain: ANSI/ASME-B18.22.1.
- G. Anchor bolts, high-strength:
1. Bolts or rod for threading: ASTM F1554-105 ksi. meeting supplementary requirement S4. Pretension to load indicated on plans.
 2. Nuts, heavy hex: ASTM-A563.
 - a. Up to 1 1/2 IN diameter: Grade D hex
 - b. Over 1-1/2 IN diameter: grade DH Heavy Hex.
 3. Washers:
 - a. Hardened Steel: ASTM F436 type 1
 - b. Load indicator type: Direct Tension Indicating Washers as manufactured by TurnaSure LLC of Langhorne, PA or approved equal, Install per manufacturers recommendations
 4. Thread tolerance: ANSI/ASME-B18.1, Class 2A.
- H. Anchor bolts, standard strength:
1. Bolts or rod for threading: ASTM A36 or ASTM F1554-36 ksi.
 2. Nuts and washers:
 - a. Nuts: ASTM A563.
 - b. Washers plain: ANSI/ASME-B18.22.1.
 3. Thread tolerance: ANSI/ASME-B18.1, Class 2A.
- I. Welding electrodes:
1. Shielded metal-arc: AWS A5.1 or AWS A5.5, E70XX
 2. Submerged-arc: AWS A5.17 or A5.23, F7X-EXXX.
 3. Gas metal-arc: AWS A5.18, ER70S-X.
 4. Flux cored-arc: AWS A5.20, E70T-X (except 2, 3, 10, GS).
- J. Headed studs and deformed bar anchors:

1. Headed studs (HS)
 - a. Fabricated from cold drawn bar stock conforming to ASTM A 108, grades 1010 through 1020.
 - b. AWS D1.1 type B.
 - c. Minimum Yield strength: 51 ksi.
 - d. Minimum tensile strength: 65 ksi over 3/8 IN diameter.
 - e. Minimum tensile strength: 55 ksi 3/8 IN diameter and under.
 2. Deformed anchor bars (DBA): Straight, unless otherwise indicated.
 - a. ASTM A496.
 - b. Minimum yield strength: 70 ksi.
 - c. Minimum tensile strength: 80 ksi.
- K. Grout: Pourable.
1. "Duragrout" as manufactured by L&M Construction Chemicals, or equal.
 2. Minimum Strength : 4000 PSI at 7 days and 8000 PSI at 28 days.
- L. Expansion anchors:
1. Expansion anchors shall be a single-end expansion shield anchor which complies with the descriptive part of Federal Specification FF-S325, Group II, Type 4, Class 1 for concrete expansion anchors. Anchors shall be Hilti Kwik Bolt TZ Expansion anchor by Hilti fastening systems of Tulsa, OK (ICC Report No. ESR-1917) or equal.
- M. Adhesive anchors:
1. Threaded rods, bolts, etc., indicated as adhesive anchors into concrete or solid masonry:
 - a. HIT HY-150 MAX - SD adhesive by Hilti Fastening Systems of Tulsa, OK (ICC Report No. ESR-3013) or equal.
 - b. Unless indicated otherwise, adhesive anchor bolt shall conform to HAS - E Standard ISO Class 5.8 by Hilti or equal. Do not field cut rods without engineer's approval.

2.2 FABRICATION

- A. General:
1. Fabricate and assemble material in shop to greatest extent possible.
 2. Use A325 bolts, twist-off type, unless otherwise indicated.
 3. One sided or other types of eccentric connections not indicated, will not be permitted without prior approval.
 4. Bevels for field welds may be flame cut provided such cutting is done automatically. Leave free of burrs and slag.
 5. Grind flush web fillets at webs notched to receive backup plates for flange groove welds.
 6. Flame cut edges of stiffener plates at field or shop butt welds. Do not shear.
 7. Accurately mill bearing ends of columns.
 8. Trusses, beams and girders over 15 m 50 FT in length shall be cambered in an amount required by the Architect. Members less than 15 m 50 FT in length shall be cambered when indicated on the drawings or otherwise fabricate such that after erection any natural camber due to rolling or assembly is upward.
 9. Cut, drill, or punch holes at right angles to surface of metal.
 - a. Do not make or enlarge holes by burning.
 - b. Make holes clean cut, without torn or ragged edges.
 - c. Remove outside burrs resulting from drilling or reaming operations with tool making 1.6 mm 1/16 IN bevel.
 - d. Provide holes in members to permit connection of work of other trades.
 10. Make allowance for draw in of tension bracing.
 11. Make splices only as indicated.

12. Headed stud type shear connectors (H.S.) and deformed bar anchors (D.B.A.), on Drawings: Automatically end welded in accordance with AWS Code.
 - a. When headed stud type shear connectors are to be either shop or field applied, clean top surface of beam flanges in shop to remove oil, scale, rust, dirt and other materials injurious to satisfactory welding.
 - b. Fillet welding of headed studs and deformed anchors is not allowed without prior approval.
 - c. Do not weld studs when temperature is below -18 degC 0 degF or surface is wet with rain or snow.
 - d. After welding, remove ceramic ferrules and maintain clean and free from substances which would interfere with function as anchor or bond of deformed anchor bars.
 - e. Quality control: Weld minimum of 2 studs at start of each production period to determine proper generator, control unit, and stud welder settings.
 - 1) These studs shall be capable of being bent 45 degrees from vertical without weld failure. These studs shall not be included as a part of the required construction.
 - 2) All production studs shall be sounded by a sharp blow with a hammer.
 - 3) If, after welding, a stud does not ring when struck by a hammer or visual inspection reveals that sound weld or full 360 degree fillet has not been obtained for a particular stud, that stud shall be struck with hammer and bent approximately 15 degrees off perpendicular to nearest end of beam.
 - 4) Studs meeting this test shall be considered acceptable and shall be left in this position.
 - 5) Studs bent beyond 15 degrees shall be considered ineffective and replaced.
 - 6) Studs failing under this test shall be replaced.
- B. Welding:
1. Welding, techniques of welding employed, appearance and quality of welds, and methods used to correct defective work shall comply with AWS Code, and requirements indicated.
 2. Test and qualify welding operators and tackers in compliance with AWS Code for position and type of welding to which they will be assigned.
 - a. Conduct tests in presence of approved testing agency.
 - b. Certification within last 12 months from a welding inspector will be acceptable provided samples of welder's work are satisfactory.
 - c. At discretion of testing agency, shop personnel continuously employed at welding process for which they have been qualified may be accepted from older qualification tests.
 3. Qualify joint welding procedures or test in accordance with AWS qualification procedures.
 4. Before start of welding work, meet with testing agency and welders to review and verify procedures.
 5. Comply with AWS Code to minimize shrinkage and distortion stress.
 6. Use back-up plates in accordance with AWS Code, extending minimum of 25 mm 1 IN either side of joint.
 7. Make flange welds before making web welds.
 8. For manual shielded metal-arc welding: Comply with Article 4.6 of AWS Code.
 9. Low hydrogen electrodes: Dry and store electrodes in compliance with AWS Code.
 10. Do not perform welding when ambient temperature is lower than -18 degC 0 degF, or where surfaces are wet or exposed to rain, snow, or high wind, or when welders are exposed to inclement conditions.
 11. Before starting welding:
 - a. Carefully plumb and align members.
 - b. Fully tighten bolts.

- c. Assembly and surface preparation shall comply with AWS Code.
- d. Preheat base metal to temperature stated in AWS Code.
 - 1) When no preheat temperature is given and base metal is below 0 degC 32 degF, preheat base metal to at least 21 degC 70 degF.
 - 2) Maintain temperature during welding.
 - 3) Preheating shall bring surface of base metal within distance from point of welding equal to thickness of thicker part being welded or 75 mm 3 IN, whichever is greater, to specified preheat temperature.
 - 4) Maintain this temperature during welding.
- e. Each welder is to provide identifying mark at welds worked on.

2.3 SURFACE PREPARATION AND SHOP-APPLIED COATINGS

- A. Surfaces not to be coated:
 - 1. Do not coat following surfaces:
 - a. Surfaces to be fireproofed with spray-on material.
 - b. Machined surfaces, surfaces adjacent to field welds, contact surfaces of bolt connections where connection is specified as slip critical, and top of top flanges of beams.
 - c. Other members for which no coating is specified.
 - 2. Clean thoroughly before shipping; remove loose mill scale, rust, dirt, oil and grease.
- B. Hot-dip Galvanized (HDG) members:
 - 1. Galvanize following members:
 - a. Members set in, or in contact with, exterior surface material, including:
 - 1) Brick ledge angles.
 - 2) Embedded items in exterior surfaces.
 - b. Exterior exposed structure not indicated to be shop otherwise shop finished.
 - c. Other members indicated.
 - 2. Clean thoroughly before galvanizing.
 - 3. Galvanize in accordance with ASTM A123.
- C. Exterior Surfaces to be shop-primed for finish paint:
 - 1. Primer: As recommended by finish (top) coat manufacturer for substrate.
 - 2. Primer: Tnemec, Series 94-H20 Hydro-Zinc.
 - 3. Primer: Sherwin-Williams Pro-Cryl Universal Acrylic Primer, B66-310 Series.
- D. Interior Surfaces to be shop-primed for finish paint:
 - 1. Primer: As recommended by finish (top) coat manufacturer for substrate.
 - 2. Primer: Tnemec, Series 94-H20 Hydro-Zinc.
 - 3. Primer: Sherwin-Williams Pro-Cryl Universal Acrylic Primer, B66-310 Series.

PART 3 - EXECUTION

3.1 ERECTION

- A. Safety:
 - 1. Contractor is solely responsible for safety. Construction means and methods and sequencing of work is the prerogative of the Contractor.
- B. Capacity of partially complete construction:
 - 1. Consider that full structural capacity of many structural members is not realized until structural assembly is complete; That is, until slabs, decks and diagonal braces are installed. Partially complete structural members shall not be loaded out of sequence without an investigation.
 - 2. Until elements of the permanent lateral bracing system of the structure are complete, temporary lateral bracing for the partially complete structure will be required.

- C. Temporary bracing:
1. Adequate temporary bracing to provide stability and resist loads to which the partially complete structure may be subjected to including construction activities and operation of equipment is the responsibility of the Contractor.
 2. If not obvious from the drawings, confer with the Architect to identify those structural elements that must be complete before the structure's permanent lateral bracing system is effective. The design of the temporary bracing system must consider the sequence and schedule of placement of such elements and effects of loads imposed on the structural steel frame by partially or completely installed work of other trades. Do not remove temporary bracing until the permanent lateral bracing system is effective.
- D. General:
1. Set base and bearing plates accurately and grout immediately as indicated.
 - a. Use metal wedges, shims or setting nuts as required.
 - b. Pack grout solidly between plate and bearing surface.
 2. Clean bearing and contact surfaces before assembly.
- E. Install A325SC bolts with washers. Install and tighten in accordance with the RCSC Specifications or in accordance with manufacturer's instructions when twist-off bolts are used.
- F. Field weld as specified in paragraph "Welding."
- G. Do not use gas cutting to correct fabrication errors on major members.
1. Gas cutting on minor members may be permitted when members are not loaded, only after approval by Architect.
- H. Tighten and leave in place erection bolts used in welded construction.
- I. Provide beveled washers to give full bearing to bolt head or nut where bolts are to be used on surfaces having slopes greater than 1:20 with a plane normal to bolt axis.
- J. After installation, touch up damaged or abraded areas of primed steel using same materials used for shop priming.
1. Clean field welds, bolted connections and abraded areas before touching up.
- K. After installation, repair galvanized surfaces damaged or abraded using zinc rich paint in accordance with ASTM A780.
1. Surfaces to be repaired with paint containing zinc dust shall be clean, dry, and free of oil, grease, preexisting paint, corrosion, and / or rust.
 2. Surfaces to be repaired shall be blast cleaned to the requirements of SPC SP10 (near white). Where circumstances do not allow blast or power tool cleaning to be used, then hand tools may be used. Cleaning shall meet the requirements of SSPC SP2 (removal of loose rust, mil scale, or paint to the degree specified by hand chipping, scraping, sanding and wire brushing)
 3. If the areas /surfaces to be repaired include welds, first remove all weld flux residue and weld spatter by blasting, chipping, grinding, or power scaling.
 4. Spray or brush apply the paints containing zinc dust to the prepared surfaces/areas. Apply the paint in accordance with the manufacturer's recommendations in a single application employing multiple passes to achieve a dry film thickness equal to the original zinc coating thickness.

END OF SECTION

Where groove welds have back-up plates, make first 3 passes with 3 mm 1/8 IN round electrodes."

SECTION 05 12 13
ARCHITECTURALLY EXPOSED STRUCTURAL STEEL

PART 1 - GENERAL**1.1 SUMMARY**

- A. Furnish labor, materials, tools, equipment, and services for Architecturally Exposed Structural Steel, as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

- A. Section covers fabrication and erection requirements in addition to those specified in Section 05 12 10 for structural steel, indicated to be Architecturally Exposed Structural Steel (AESS).
- B. Quality standards, qualifications, source quality control and testing and inspection, specified in Section 05 12 10, shall apply to Architecturally Exposed Structural Steel.
 - 1. Fabricator and erector shall have successfully completed AESS work similar to work indicated for this project.
- C. Tolerances: AISC, Code of Standard Practice for Steel Buildings and Bridges, Section 10, or as noted.
- D. Final design of connections not defined on Contract Documents as specified in Section 05 12 10.

1.3 PRE-INSTALLATION CONFERENCE

- A. Schedule and conduct conference at project site to comply with requirements of Section 01 31 19.
 - 1. Attendees shall include Contractor, Fabricator, Erector, finish painter.
 - 2. Topics for discussion shall include coordination requirements for shipping, special handling, attachment of safety cables, temporary erection bracing, and touch-up painting.

1.4 MOCK-UP

- A. Submit shop drawings for proposed mock-up sample prior to fabrication.
- B. Approved sample shall serve as the basis for acceptance for all AESS assemblies.
- C. Mock-up shall include no less than following:
 - 1. Plate seam.
 - 2. Butt or miter joint in plate, rolled sections, or both.
 - 3. Welds required for installation.

1.5 SUBMITTALS

- A. Shop Drawings:
 - 1. Provide erection drawings indicating AESS members.
 - 2. Details indicating compliance with fabrication and erection requirements, including connections consistent with concepts indicated in drawings.
 - 3. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, showing size, length and type of each weld, and identifying grinding, finish and profile of each weld.

4. Indicate bolts by type, size, finish and length, distinguishing between shop and field bolts, identifying high-strength bolted, direct-tensioned shear/bearing connections, and showing which direction bolt heads are to be oriented.
 5. Indicate surfaces and edges exposed and class of surface preparation used.
 6. Indicate tolerances and erection requirements as defined in drawings or specified in this section.
- B. Product Data:
1. Source and certification of quality for high-strength bolts, nuts and washers.
 2. Technical data on base plate grout.
- C. Project Information:
1. Fabricator and Erector Qualifications:
 - a. List completed project names and addresses, and names and addresses of their Architects and Owners.
 - b. Fabricator's AISC certification or name of independent testing agency for use by non-certified fabricator.
 - c. Proof fabricator has 10 years experience in fabrication of structural steel for buildings.
 - d. Steel erector's AISC Certification or proof that steel erector has 10 years experience in erection of structural steel.
 2. Inspection reports and certification of shop fabrication by independent testing laboratory for non-certified fabricator.
 3. Welding Procedure Specification (WPS) for shop and field welds.
- D. Contract Closeout Information:
1. Certificate by fabricator that steel was fabricated in accordance with approved construction documents.
 2. Certificate by erector that steel was erected in accordance with approved erection plans and specifications.

PART 2 - MATERIALS

2.1 ARCHITECTURALLY EXPOSED STRUCTURAL STEEL

- A. Specified in Section 05 12 10.
- B. Epoxy filler:
1. Solvent resistant, two component metal and epoxy compound compatible with required protective coating systems.
 2. Acceptable product:
 - a. Tnemec, 215 Surfacing Epoxy.
- C. Primer:
1. As recommended by finish top coat manufacturer for substrate.

2.2 FABRICATION

- A. Fabricate and assemble in shop to greatest extent possible.
1. Locate field joints at concealed locations unless otherwise indicated.
 2. Detail assemblies to minimize field handling and expedite erection.
- B. Fabricate with exposed surfaces smooth, square and with consistent surface quality.
- C. Fabrication Tolerance: Fabricate steel to one-half of normal tolerances specified in AISC Code of Standard Practice for Steel Buildings and Bridges, Section 10.
- D. Welds:
1. Grind welds smooth.

2. Groove welds: Make flush to surfaces each side to within + 1/16 IN to – 0 IN of plate thickness.
 3. Contouring and Blending of Welds: Oversize fillet welds for grinding to smooth transitions.
 4. Continuous welds: Uniform size and profile.
 5. Minimize weld show-through at locations where welding on far side of exposed connection.
- E. Coping and Blocking Tolerance, and Joint Gap Tolerance: Uniform gap of 1/8 IN +/- 1/32 IN.
- F. Fabricate each piece such that piece mark is fully hidden in the final structure or made with such media to permit full removal after erection.
- G. Steel shall be delivered with no mill marks in exposed locations.
1. Mill marks shall be omitted by cutting of mill material to appropriate lengths where possible.
 2. Where not possible, fill and grind mark area to a surface consistent with surrounding surface.
 3. Filler caulk, or body putty type materials, other than filler metal deposited by welding process, is not acceptable for remedial work.
 4. Epoxy filler may be applied to pockets, voids, pitting, or other blemishes on exposed surfaces of interior steel to be painted, including welds.
- H. All edges of sheared, punched or flame-cut steel shall be ground smooth.
- I. Roll members to final curved shape in the shop and tied during shipping to prevent stress relieving.
1. Distortion of web or stem and of outstanding flanges or legs of angles will be visibly acceptable only if not perceived from a distance of 20 FT under any lighting condition.
 2. Tolerances for vertical and horizontal walls of regular HHS members after rolling shall be specified dimension +/- 1/2 IN.
- J. Seal weld ends of round and rectangular hollow structural sections with 3/8 IN thick closure plates, and provide continuous sealed welds at angle to gusset plate connections and similar locations where exposed to weather.
- K. Shop Connections: Comply with Section 05 12 10, and for:
1. Bolt Connections: Provide bolt type and finish and align bolt heads as indicated on approved shop erection drawings.
 2. Weld Connections: Comply with AWS-D1.1, and assemble and weld build-up sections by methods maintaining alignment of members without warp exceeding tolerance specified.

2.3 SHOP PRIMING

- A. Shop-prime steel surfaces except surfaces embedded in concrete or mortar, and surfaces to be field welded.
1. Extend priming of partially embedded members to a depth of 2 IN.
- B. Do not prime surfaces to be high-strength bolted with slip-critical connections if primer does not meet specified AISC slip coefficient.
- C. Surface Preparation: Clean surfaces to be painted by removing loose rust, loose mill scale, and spatter, slag or flux deposits.
1. Prepare surfaces concealed by other work minimally according to SSPC-P3 Power Tool Cleaning.
 2. Prepare exterior surfaces minimally according to SSPC-P6 Commercial Blast Cleaning.

3. Coordinate required blast profile with approved paint submittal prior to beginning surface preparation.
- D. Priming:
1. Apply primer immediately after surface preparation, in accordance with manufacturer's instructions.
 2. Provide a dry film thickness of not less than 2.5 mils and with full coverage of joints, corners, edges and other exposed surfaces.
 3. Stripe paint lap joints, plate edges, corners, crevices, bolts, welds and sharp edges.
 4. Apply two (2) coats of shop primer to surfaces inaccessible after assembly or erection.

2.4 GALVANIZING

- A. Where galvanizing is indicated, apply zinc coating by hot-dip process according to ASTM A123.
1. Fabricate galvanized assemblies for all field connections made by bolted connections.
 2. Provide galvanized finish in consistent color and surface texture throughout.

2.5 FINISH PAINTING

- A. Finish painting is specified in Section 09 91 13 for exterior assemblies and Section 09 91 23 for interior assemblies.
- B. Finish painting shall be field applied after erection.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify members are free of twist, kinks, gouges or other imperfections which may result in rejection of the appearance of the member.
- B. Replace defective members or correct defects.

3.2 PREPARATION

- A. Provide connections for temporary shoring, bracing and supports only where indicated on approved shop drawings.
- B. Temporary connections not shown on shop drawings shall be made at locations not exposed to view in the final structure.
- C. Handle, lift, and align pieces using padded slings and other protection required to maintain appearance of through process of erection.
- D. Handle to prevent twisting or warping of members.

3.3 ERECTION

- A. Set accurately in locations and to elevations indicated and according to AISC specifications, as specified in Section 05 12 10 and per following:
1. Erection Tolerances: AISC Code of Standard Practice for Steel Buildings and Bridges Section 7, except Section 10, where AESS is located within 20 FT of personnel.
 2. Provide field welds complying with the same requirements required for welds during fabrication, including grinding for flush finish conditions.
 - a. Assemble and weld build-up sections by methods maintaining true alignment of axes without warp.

- b. Verify weld sizes, fabrication sequence and equipment used will limit distortion to acceptable tolerances.
3. Provide bolting complying with same requirements required for bolting during fabrication, including orientation of bolt heads to same side.
4. Remove run-out tabs, erection bolts and other steel members added to connections to allow for alignment, fit-up or field welding,
 - a. Make remaining surfaces made smooth to match adjacent surfaces.
 - b. Holes for erection bolts shall be plug welded and ground smooth.
 - c. Holes cut to permit field welding shall be filled by procedures to minimize restraint and thermal stress.
5. Ream holes to permit bolts; burning and use of drift pins are not allowed.
6. Replace misaligned connection plates where holes cannot be aligned for acceptable final appearance.
7. Remove and replace welded material deemed inferior to quality of mock-up.
8. Repair only when proposed procedures are approved.

3.4 ADJUSTING AND CLEANING

- A. Clean and touch-up painting of field welds, bolted connections and abraded areas.
 1. Touch-up priming, painting, or both:
 2. Stripe paint lap joints, plate edges, corners, crevices, bolts, welds and sharp edges as required.
 3. Finish to blend with adjacent surfaces and comply with paint manufacturer's instructions.
- B. Galvanized Surfaces: Clean field welds, bolted connections and abraded areas, and repair galvanizing in compliance with ASTM A780.

END OF SECTION

SECTION 05 21 10
STEEL JOISTS**PART 1 - GENERAL****1.1 SUMMARY**

- A. Furnish labor, materials, tools, equipment, and services for Steel Joists, as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

- A. Fabrication standards for joists and accessories: Steel Joist Institute "Standard Specification and Load Tables" for open web, long span and deep long span steel joists; American Institute of Steel Construction (AISC) "Specifications for Design, Fabrication and Erection of Structural Steel for Buildings," (referred to as AISC Specifications).
- B. Standard for welders and welding work: AWS "Standard Qualification Procedure."
- C. Architect reserves right to observe joists in manufacturer's shop during fabrication.
- D. Architect reserves right to observe and require testing of joists welded in place.
 - 1. Remove and replace work found not to comply with Contract requirements.

1.3 SUBMITTALS

- A. Shop Drawings:
 - 1. Show complete details including layout, special connections, bridging, jointing and accessories.
- B. Project Information:
 - 1. Engineering calculations indicating design moments, shears, and other forces sealed by registered Engineer, licensed to practice Structural Engineering in the State of MO.
 - 2. Manufacturer's certification that steel joists comply with specified requirements and steel joist institutes standard load tables.
 - 3. Manufacturer's certification along with calculations that joists for special loads indicated on drawings have been designed and are capable of supporting all design loads for the spans as shown on the drawings.
 - a. Certification and calculations shall be submitted prior to or along with shop drawings.
 - b. Load combinations as specified by the building code. Where special loads only are shown, combine with typical loads or capacities for adjacent joists.

PART 2 - PRODUCTS**2.1 MATERIALS**

- A. Steel: Comply with SJI and AISC Specifications.
- B. Unfinished threaded fasteners: ASTM A307, Grade-A, regular hexagon type, low carbon steel, with ANSI B27.2, Type B, carbon steel washers.

- C. High-strength threaded fasteners: ASTM A325 or ASTM A490 as required, heavy hexagon structural bolts with nuts and hardened washers.
- A. Prime Paint: Comply with SJI and AISC except that asphalt type paint is not acceptable.
 - 1. Shop coat of red lead or rust-inhibitive paint standard with manufacturer.
 - 2. Comply with SSPC-15.
 - 3. Special coating is required for joists in the wash bay. See 09 91 00.
- B. Bedding Mortar:
 - 1. Portland cement and sand, mixed at a ratio of 1 part cement to 3 parts sand, measured by volume, with only enough water for placement and hydration.
 - 2. Shrinkage-resistant compound complying with Corps of Engineer's CRD-C588, Type M.

2.2 FABRICATION

- A. Fabricate in accord with SJI and AISC specifications and as follows:
 - 1. Do not splice principal tension members.
 - 2. Make shop connections and splices using either arc or resistance welding.
 - 3. Design and fabricate for maximum deflection of 1/360 of clear span under design live load.
 - 4. Shop holes, field holes, and enlargement of holes will not be permitted unless approved by Architect.
 - 5. Fabricate bearing ends to provide following minimum bearing unless otherwise indicated.

BEARING MATERIAL	K SERIES	LH AND DLH SERIES	JOIST GIRDERS
Masonry or Concrete	4 IN	6 IN	8 IN
Steel	2-1/2 IN	4 IN	4 IN

- B. Where special or concentrated loads are indicated, reinforce joist and develop details as necessary for support.
- C. Provide extended bottom chords where indicated. Comply with SJI and AISC requirements and load tables.
- D. Provide extended top chords where indicated. Comply with SJI and AISC requirements and load tables.
- E. Provide ceiling extensions in areas having ceilings attached directly to joist bottom chord.
 - 1. Provide either an extended bottom chord or a separate unit of sufficient strength to support ceiling construction.
 - 2. Extend ends to within 1/2 IN of wall surface.
- F. Remove loose scale, heavy rust, and other foreign materials from fabricated joists and accessories.
- G. Apply one shop coat of steel joist primer paint to steel joists and accessories, by spray, dipping, or other method to provide continuous dry paint film thickness of not less than 0.50 mil.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions under which steel joists are to be installed for conditions detrimental to proper and timely completion of Work.
- B. Do not proceed with Work until unsatisfactory conditions have been corrected.
 - 1. Do not start placement of steel joists until supporting work is in place and secured.

3.2 ERECTION

- A. Deliver, store and handle steel joists as recommended by SJI and AISC.
- B. Do not install joists damaged so that strength is impaired.
- C. Where not specifically indicated otherwise, place and secure steel joists in accordance with SJI and AISC Specifications and as specified. Secure joists along column centerlines in accordance with OSHA standards for erection safety
- D. Field weld joists to supporting steel framework in accordance with SJI and AISC - Specifications for type of joists used. Coordinate welding sequence and procedure with placing of joists.
- E. Secure joists resting on masonry or concrete bearing surfaces by bedding in mortar and anchoring to masonry or concrete construction as specified in SJI and AISC Specifications for type of steel joist used.
- F. Place joists on supporting work, adjust and align in accurate location and spacing before permanently fastening.
 - 1. Provide end bearing and anchorages to secure joists to supporting members or walls in accord with SJI and AISC Specifications, unless otherwise indicated.
 - 2. When joists do not bear flush on supporting member or wall, take corrective measures to ensure full bearing, as directed by Architect.
- G. Provide bridging in accord with SJI and AISC Specifications, where not specifically indicated otherwise, except as modified herein.
 - 1. Provide diagonal type bridging as required and as indicated.
 - 2. Provide additional bridging at each line between exterior and first interior joist and then at every 12th joist space.
- H. Completely install bridging before loads are applied.
 - 1. Anchor ends of bridging lines at top and bottom chords where terminating at walls or beams.
 - 2. Provide bridging connections at top and bottom chords capable of safely resisting a force of 500, 1000 and 1500 LB for open web, long span and deep long span joists respectively.
- I. Do not overload joists.
- J. Remove or repair damaged joists or other work, to satisfaction of Architect.
- K. After installation, paint field bolt heads and nuts, welds and abraded or rusty surfaces on joists and steel supporting members.
 - 1. Wire brush surfaces and clean with solvent before painting.
 - 2. Use same type of paint as used for shop painting.

END OF SECTION

SECTION 05 31 23
METAL ROOF DECKING**PART 1 - GENERAL****1.1 SUMMARY**

- A. Furnish all labor, materials, tools, equipment, and services for Metal Roof Decking, as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

- A. Comply with provisions of following codes and standards, except as otherwise indicated.
 - 1. AISI "Specification for Design of Cold-Formed Steel Structural Members."
 - 2. Steel Deck Institute (SDI), "Steel Roof Decking Design Manual."
 - 3. AWS "Sheet Steel in Structures, Specification for Welding" AWS D1.3.
 - 4. International Conference of Building Officials (ICBO).
- B. Qualify welding processes and operations in accordance with AWS "Standard Qualification Procedure."

1.3 SUBMITTALS

- A. Shop Drawings:
 - 1. Complete layout indicating types of deck panels, anchorage, supplementary framing, cut openings, accessories, and thicknesses.
- B. Product Data:
 - 1. Manufacturer's load tables for deck to be furnished on this project.

PART 2 - PRODUCTS**2.1 METAL ROOF DECKING - 38 MM 1-1/2 IN DEEP**

- A. Acceptable manufacturers:
 - 1. Metal roof decking, 38 mm 1-1/2 IN deep:
 - a. Base:
 - 1) BHP Steel Building Products; Type B-36.
 - 2) Consolidated Systems B-Dek
 - 3) Roof Deck; Type B-2.
 - 4) United Steel Deck; Type B.
 - 5) Verco Manufacturing; Type HSB-36.
 - 6) Vulcraft; Type 1.5B.
 - 7) Wheeling Corrugating; Types B, BW, BW-36.
 - 2. Other manufacturers desiring approval comply with Section 00 26 00.
- B. Metal roof decking, 38 mm 1-1/2 IN deep: Size as indicated on structural drawings.
 - 1. Galvanized.
 - 2. Galvanized decking: ASTM-A653, Z180 G60 zinc coating, Fy= 230 MPa 33 KSI, Structural Quality.

2.2 OTHER MATERIALS

- A. Welding rod: E-60XX or greater in accordance with AWS D1.3

- B. Mechanical Fasteners:
 - 1. Definition: Corrosion-resistant, low-velocity, power-actuated or pneumatically driven carbon-steel fasteners; or self-drilling, self-threading screws.
 - 2. Acceptable manufacturers:
 - a. Powder actuated:
 - 1) Base:
 - a) Hilti Inc., steel deck fastener.
 - b. Pneumatically driven:
 - 1) Base
 - a) Punetek, Inc.
 - c. Self drilling, self threading screws: Corrosion-resistant, hexagonal washer head; self-drilling, carbon-steel screws, 4.8mm No. 10 diameter min size.
 - 1) Base;
 - a) Hilti, Inc
 - b) Elco Textron
 - c) Buildex
 - 3. Other manufacturers desiring approval comply with Section 00 26 00.
- C. Steel shapes, miscellaneous: ASTM-A36.
- D. Galvanizing for metal accessories: ASTM-A653, Z180 G60.
- E. Galvanizing repair paint: High zinc dust content paint, Mil-P-21035 (ships).
- F. Metal closure strips: Galvanized sheet steel, minimum 0.86 mm 0.034 IN thick before coating, ASTM-A653, Z180 G60 galvanized. See Part 3 - Execution for locations.

2.3 FABRICATION

- A. Form in lengths to span 3 or more support spacings, with flush, telescoped or nested 50 mm 2 IN end laps.
 - 1. Use deck configurations complying with SDI Basic Design Specifications and as indicated.
- B. Form metal closure strips to configuration required to provide tight-fitting closures at open ends and sides of decking.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine areas and conditions under which deck units are to be installed for conditions detrimental to proper and timely completion of work.
- B. Do not proceed with work until unsatisfactory conditions have been corrected.
- C. Start of installation constitutes acceptance of responsibility for correct installation and performance.

3.2 INSTALLATION – GENERAL

- A. Do not overload supporting members.
- B. Install roof deck units and accessories as indicated.
- C. Do not start placement of roof deck units until supporting members are installed complete.
- D. Place each deck unit on supporting structural frame, adjust to final position, accurately align with ends bearing on supporting members.
 - 1. Lap units at ends no less than 50 mm 2 IN.
 - 2. Do not stretch or contract side-lap interlocks.

3. Place deck units flat and square and secure to framing without warp or excessive deflection.
 4. Install deck ends over supporting frame with a minimum end bearing of 38 mm 1-1/2 IN.
- E. Plug weld sizes specified are effective fusion diameter of welds.
1. Weld metal shall penetrate layers of deck material at ends laps and have good fusion to supporting members.
- F. Remove and replace decking which is structurally weak or unsound or which has burn holes due to improper welding or which Architect declares defective.
- G. Cut and fit roof units and accessories around other work projecting through or adjacent to roof decking.
1. Make cutting and fitting neat, square and trim.
 2. Neatly and accurately install reinforcing at openings except:
 - a. Circular openings less than 150 mm 6 IN diameter.
 - b. Rectangular openings having no side dimension greater than 150 mm 6 IN.
 3. Reinforce openings between 150mm 6 IN and 305mm 12 IN with 0.9 mm 20 GA flat steel sheet 305mm 12 IN greater in each dimension than opening. Place sheet around opening and fusion weld to top surface of deck at each corner and each side midway between each corner.
 4. For roof openings larger than 305mm 12 IN and at roof drains: Support deck edges as indicated on Drawings
- H. Install metal closure strips for support of roof insulation.
1. Provide where rib openings in top surface of roof decking occur adjacent to edge and openings.
 2. Weld closure strips into position.
- I. Install metal closure strips at open uncovered ends and edges of roof decking, and in voids between decking and other construction.
1. Weld into position to provide a complete decking installation.

3.3 FASTENING OF ROOF DECKING

- A. Welded connection requirements:
1. Fasten roof-deck panels to steel supporting members by arc spot (puddle) welds 16 mm 1/2 IN effective diameter or arc seam welds with an equal perimeter that is not less than 38 mm 1-1/2 IN long.
 - a. Weld Spacing:
 - 1) As indicated on structural drawings
 - 2) Space welds: 450mm 18 IN apart, maximum.
 2. Side-Lap and Perimeter Edge Fastening: As indicated on structural drawings.
 - a. Fasten side laps and perimeter edges of panels between supports, at intervals not exceeding the lesser of 1/2 of the span or 450 mm 18 IN, and as follows:
 - b. Mechanically fasten with self-drilling, 4.8mm No.10 diameter or larger, carbon-steel screws @ 12" o.c.
 - c. Mechanically clinch or button punch @ 12" o.c.
 - d. Fasten with a minimum of 38 mm 1-1/2 IN -long welds.
- B. Mechanical connection requirements (Alternate)
1. Mechanical fasteners (powder actuated or pneumatically driven steel pins) may be used in lieu of welding indicated to fasten deck to supports. Locate mechanical fasteners and install according to manufacturer's written instructions. The contractor must submit the proposed fastening configuration complete with diaphragm capacities. Diaphragm capacities must meet or exceed capacities based on connections shown in structural drawings.
 - a. Pin size, spacing, and accessories:

- 1) Pin diameter and length per manufacturer's instructions for numbers of layers, deck gage, and steel flange thickness at a given condition.
- 2) Install steel washers or provide pins with integral washers at each pin location. Washer size per manufacturer requirements.

3.4 CLEAN AND TOUCH-UP

- A. Wire brush, clean and paint scarred areas, welds and rust spots on top surfaces of decking units and supporting steel members.
- B. Touch-up damaged galvanized surfaces with galvanizing repair paint applied in accordance with manufacturer's instructions.
- C. Touch-up shop painted surfaces with same paint used in shop, as recommended by deck manufacturer.

END OF SECTION

SECTION 05 36 00
COMPOSITE METAL FORM DECK

PART 1 - GENERAL**1.1 SUMMARY**

- A. Furnish labor, materials, tools, equipment, and services for Composite Metal Form Deck, as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

- A. Standards:
 - 1. AISI; Specification for Design of Cold-Formed Steel Structural Members.
 - 2. ANSI/AWS-D1.3; Structural Welding Code - Sheet Steel.
 - 3. SDI; Design manual for composite decks, form decks and roof decks.
- B. Qualify welding processes and welding operators in accordance with AWS qualification procedures.
- C. Minimum thickness:
 - 1. Where gage of metal is indicated, provide following minimum uncoated steel thickness, unless following performance requirements require greater thickness.

Gage	Minimum Thickness
20	0.034 IN
19	0.040 IN
18	0.045 IN
17	0.051 IN
16	0.057 IN

- D. Performance requirements:
 - 1. Provide form deck to act as bottom form for cast-in-place concrete slabs and which will become positive slab reinforcement through mechanical anchorage after concrete hardens.
 - 2. Provide deck thickness such that maximum deck stress shall not exceed 0.6 its yield strength under combined weights of wet concrete(including weight of additional concrete due to structural deflection), deck, and construction live loading of either 20 PSF uniform load or 150 LB concentrated load on a 1 FT wide section of deck.
 - 3. Provide deck with adequate thickness to limit maximum deflection relative to supporting structural members to 1/180 of clear span or 3/4 IN whichever is smaller, caused by combined weights of wet concrete and deck.
 - 4. Provide decking with manufacturers standard male – female side lap joints
 - 5. Gage of deck furnished shall not be less than that indicated on the drawings.
 - 6. Configuration, physical and chemical properties and composite superimposed load carrying capacity of deck units furnished shall conform to manufacturer's catalog current at time bids are received.
 - 7. Provide accessories (pour stops, column closures, end closures, cover plates, and girder fillers) as needed to prevent concrete leakage.

1.3 SUBMITTALS

- A. Shop Drawings:
 - 1. Complete layout indicating types of deck panels, anchorage, supplementary framing, cut openings, accessories, deck thicknesses.
 - 2. Indicate areas requiring shoring on the shop drawings.
- B. Product Data:
 - 1. Manufacturer's load tables for deck to be furnished on this project.
- C. Product Information
 - 1. Manufacturers analysis of unshored span limits
 - 2. Shoring design and documentation prepared by a Licensed Structural Engineer

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Acceptable manufacturers and designations:
 - 1. Composite metal form deck, 2 IN:
 - a. Base:
 - 1) ASC Profiles; Type 2W.
 - 2) Consolidated Systems; Type CFD-2.
 - 3) United Steel Deck; Type 2 IN Lok Floor.
 - 4) Verco Manufacturing; Type W2 Formlok.
 - 5) Vulcraft; Type 2VLI.
 - 2. Composite metal form deck, 3 IN:
 - a. Base:
 - 1) ASC Profiles; Type 3W.
 - 2) Consolidated Systems; Type CFD-3.
 - 3) United Steel Deck; Type 3 IN Lok Floor.
 - 4) Verco Manufacturing; Type W3 Formlok.
 - 5) Vulcraft; Type 3VLI.
 - 3. Other manufacturers desiring approval comply with Section 00 26 00.
- B. Composite metal form deck:
 - 1. Deck shall be cold formed from steel sheets, conforming to ASTM-A653, Structural Quality, Grade-40 with G60 coating.
- C. Accessories:
 - 1. Sheet steel closures, cover plates and other sheet steel accessories: Use same material and coating as for deck.

2.2 FABRICATION

- A. Where possible, deck shall extend over three or more spans with butted end laps.
- B. Form closures and cover plates to configuration required to form concrete and/or to prevent concrete leakage.
- C. End laps and accessories shall be located and be of a style so as not to reduce capacity of field applied studs for composite beams.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine areas and conditions under which deck units are to be installed for conditions detrimental to proper and timely completion of work.

- B. Correct unsatisfactory conditions.

3.2 INSTALLATION

A. General:

1. Do not overload supporting members.
2. Unless specifically noted otherwise, provide composite metal form deck for concrete slabs supported directly or indirectly by structural steel frame.
3. Install deck units and accessories in accordance with final shop drawings and as specified herein.
4. Do not start placing units before supporting members are completely installed in place.
5. Bear deck units on supporting members minimum of 2 IN. Butt units tightly together at centerline of support. Place abutting units in accurate and close alignment for entire length of run.
6. Neatly cut and fit deck units and accessories around columns, walls, and other objects projecting through or adjacent to deck. Install closures and cover plates as required to prevent concrete leakage.
7. Install shoring where indicated on shop drawings

B. Openings:

1. Deliver deck to job site intact when openings in deck are indicated on drawings to be installed after concrete fill is cured. Openings installed in this manner shall be paid for by trade requiring opening.
2. Where openings in floor are framed, deliver deck to job site cut to proper length.

C. Fastening – Welded Connectors:

1. For welding deck to supports, employ only welders, qualified under AWS qualification procedures, and experienced in welding light gauge metal.
2. Minimum deck fastening requirements:
 - a. At end of each unit and at intermediate supports: Puddle welds at 12 IN on center with not less than two welds per support.
 - b. At exterior beam parallel to deck span: Puddle welds or 1-1/4 IN seam welds at 24 IN on center.
 - c. At male-female side laps, 1-1/2 IN long seam welds or button punching at 24 IN on center.
 - d. At lapped side laps, 1-1/2 IN long seam welds at 24 IN on center.
 - e. Sheet metal closures, cover plates: Self-drilling screws or tack welds at 24 IN on center.
3. Verify that minimum deck fastening requirements are adequate for safely supporting material and construction loads placed on deck from time of deck placement to time of concrete placement. Additional fastening required to accomplish this shall be provided and paid for by Contractor.
4. Puddle welds shall have effective fusion diameter not less than 1/2 IN. Weld metal shall penetrate layers of deck material at end laps and be thoroughly fused to supporting members.

END OF SECTION

SECTION 05 40 00 COLD-FORMED METAL FRAMING

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Cold-Formed Metal Framing as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

- A. ASTM A653: Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.
- B. ASTM C1007: Standard Specification for Installation of Load Bearing (Transverse and Axial) Steel Studs and Related Accessories
- C. AISI Standard for Cold-Formed Steel Framing General Provisions.

1.3 DESIGN CRITERIA

- A. Provide engineering design performed and sealed by registered Engineer, licensed to practice Structural Engineering in the State of MO.
- B. Design Loads:
 - 1. Design Exterior Stud Wall System to satisfy requirements of applicable building codes as locally amended, but not less than loads shown in contract documents.
 - a. Design Exterior Soffits similarly.
 - b. Include superimposed loads.
 - 2. Limit lateral deflection of stud wall system due to wind or earthquake as follows:

MAXIMUM ALLOWABLE DEFLECTION	
Exterior Finish Material	Deflection Limit
Marble, Granite and other Stone Veneers	L/720
Brick and Concrete Masonry Veneers	L/600
Portland Cement Plaster (Stucco)	L/360
Manufactured Stone Veneer, Adhered Stone Veneer, Thin Brick, Tile and similar Mortar-Set finishes.	L/360
Metal Panels, Curtainwalls, and other flexible wall finishes.	L/240

- 3. Select stud gauge and spacing as required to limit deflection due to applied loads.
 - a. Utilize strength properties of metal stud only. Disregard contribution of facings such as Gypsum Wall Board and Gypsum Sheathing.
- 4. Size and define headers and reinforcing members around openings.
- 5. Develop details defining method of fastening throughout system.
- 6. Design system to accommodate in plane wind and seismic loads.
- 7. Coordinate and design wall system to accommodate loads and movements from adjacent exterior wall and soffit systems.
- 8. In addition to gravity loads, design framing system to resist wind uplift at soffits.

1.4 SUBMITTALS

- A. Project Information:
 - 1. Manufacture identification.
 - 2. Complete Building Elevations defining framing member sizes, locations, and connection details.
 - a. Show openings, edges and support conditions that have been field verified with respect to location.
 - b. Show openings, edges and support conditions that have coordinated with respect to physical requirements of items to be installed in or on exterior wall system.
 - 3. Details and isometrics at windows showing layouts of Air Barrier Flashings and sequence of installation.
 - 4. Structural calculations.
 - 5. Certification Exterior Stud Wall System has been designed, to satisfy specified design criteria, sealed by registered Engineer, licensed to practice Structural Engineering in the State of MO.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Exterior metal studs:
 - 1. Base:
 - 2. Telling Industries.Optional:
 - a. California Expanded Metal Products Co.
 - b. Custom Stud Inc.
 - c. Marino\WARE
 - d. MRI Steel Framing LLC
 - e. The Steel Network
 - f. ClarkDietrich Building Systems
- B. Galvanizing repair coating:
 - 1. Base:
 - a. Tnemec
 - 2. Optional:
 - a. ZRC Worldwide
 - b. Sherwin Williams
- C. Other manufacturers desiring approval comply with Section 00 26 00.

2.2 MATERIALS

- A. Exterior Studs:
 - 1. Galvanized 33ksi steel studs, runner channels and track, bracing, and accessories, minimum G60 galvanized.
 - a. Revise thickness and minimum requirements if 50 KSI steel is used.
 - 2. Stud depth:
 - a. As indicated on Drawings.
 - 3. Span:
 - a. As indicated on Drawings.
 - 4. Stud spacing:
 - a. Use closer spacing as needed to satisfy load deflection criteria.
 - b. 12 IN OC minimum.
 - c. 16 IN OC maximum.
 - 5. Minimum thickness for Studs, Runners and Tracks
 - a. 43 mils (18 GA).
 - b. Use heavier members where needed to satisfy loading and deflection criteria.
 - 6. Minimum flange on Deep-Leg runners: 2 IN.

7. Runner fasteners:
 - a. Power driven fasteners.
 - b. Minimum 190 LB shear and bearing.
8. Headers:
 - a. C-shapes used to form header beams, of
 - b. Web depths required and with stiffened flanges.
 - c. Thickness (Gauge): As determined by engineering calculations for specific openings.
- B. Galvanizing repair coating:
 1. Tnemec Series 94-H20 Hydro-Zinc.
 2. ZRC Worldwide, Galvilite 221.
 3. Sherwin Williams Zinc Clad III HS 100.
- C. Wood Sheathing: Specified in Section 06 11 10.
- D. Gypsum Sheathing: Specified in Section 06 16 43.
- E. Exterior Joint Sealants: Specified in Section 07 92 13.
- F. Gypsum wallboard, interior: Specified in Section 09 29 00.
- G. Insulation and Vapor Retarder: Specified in Section 07 21 00.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine substrate for suitability to accept work.
- B. Start of work constitutes acceptance of substrate and responsibility for performance.

3.2 ERECTION

- A. Studs and runners:
 1. Align outside deep leg runner track accurately according to exterior wall layout.
 2. Fasten 12 IN OC, or as needed to satisfy design criteria.
 3. Position studs vertically in inside deep leg runners at required spacing.
 4. Install minimum of two (2) studs each side of openings; use more if required to meet loadings.
 5. Anchorage:
 - a. Top:
 - 1) Allow 3/4 IN clearance between top of inside deep leg runner and outside deep leg runner.
 - 2) Do not fasten inside deep leg runner to outside deep leg runner.
 - 3) Fasten studs to inside deep leg runner.
 - b. Bottom:
 - 1) Anchor each stud at bottom to runners with two, 3/8 IN minimum, type S-12 pan head screws.
 6. Where stud design is outside edge of floor slab, provide galvanized connectors designed for loading requirements and allow individual floor movement without affecting integrity of stud system.
 7. Shop weld assemblies as required to meet design requirements.
 8. Touch-up burned off or abraded galvanizing with galvanizing repair coating.
- B. Openings: Install header, jamb, and sill framing system per approved engineering documents
- C. Expansion Joints at Portland cement plaster walls and soffits:
 1. Utilize double studs, spaced 3/8 IN apart, where expansion joints are indicated.

2. Sheathing shall not be continuous across expansion joints.
- A. Expansion Joints at DEFS Soffits:
 1. Utilize double studs, spaced 3/8 IN apart, where expansion joints are indicated.
 2. Sheathing shall not be continuous across expansion joints.
- B. Metal Wall Backing: Specified in Section 09 22 16.
 1. Coordinate installation of metal wall backing used to support wall-supported items with installation of exterior stud wall system.
 2. See Section 09 22 16 for items requiring metal wall backing.
- C. Wood Wall Blocking: Specified in Section 06 10 53.
 1. Coordinate installation of wood wall blocking used to support wall-supported items with installation of exterior stud wall system specified herein.
 2. See Section 06 10 53 for items requiring wood wall blocking.

3.3 PROTECTION

- A. Protect erected wall and openings with temporary covers until finish, roofing, flashing, and windows are installed.

END OF SECTION

SECTION 05 50 00**METAL FABRICATIONS****PART I - GENERAL****1.1 SUMMARY****A. Description**

This Section specifies requirements for furnishing and installing metal hardware, aluminum hardware, and miscellaneous steels as indicated on the Contract Drawings and specified herein. The work under this Section includes furnishing all labor, materials, tools and equipment necessary, including metal surface preparation, galvanization, painting, connections, leveling and base plates, grouts, setting devices, and field modifications such as drilling, welding and re-fabrication as required, to ensure proper fit and complete the work.

1.2 REFERENCED STANDARDS

<u>Sponsor</u>	<u>Number</u>	<u>Subject</u>
ASTM	A 27	Specification for Steel Castings, Carbon, for General Application
ASTM	A 36	Specification for Carbon Structural Steel
ASTM	A 47	Specification for Ferric Malleable Iron Castings
ASTM	A 53	Specification for Steel Pipe, Black and Hot-Dipped, Zinc Coated, Welded and Seamless
ASTM	A 123	Specification for Zinc (Hot Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars, and Strip
ASTM	A 153	Specification for Zinc Coating (Hot Dip) on Iron and Steel Hardware
ASTM	A 307	Specification for Carbon Steel Externally Threaded Standard Fasteners
ASTM	A 325	Specification for High-Strength Bolts for Structural Steel Joints, Including Suitable Nuts and Plain Hardened Washers
ASTM	A 449	Standard Specification for Quenched and Tempered Steel Bolts and Studs
ASTM	A 500	Standard Specification for Cold-formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM	A 563	Standard Specification for Carbon and Alloy Steel Nuts
ASTM	A 780	Specification for Practice for Repair of Damaged Hot-Dip Galvanized Coatings

ASTM	B 209	Specification for Aluminum and Aluminum Alloy Sheet and Plate
ASTM	B 221	Specification for Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM	B 429	Specification for Aluminum-Alloy Extruded Structural Pipe and Tube
ASTM	B 633	Standard Specification for Electrodeposited coatings of Zinc on Iron and Steel
ASTM	C 1107	Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Non-shrink)
ASTM	E 488	Standard Test Methods for Strength of Anchors in Concrete and Masonry Elements
ASTM	F 669	Specifications for Strength Requirements of Metal Posts and Rails for Industrial Chain Link Fence
ASTM	F 959	Standard Specification for Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners
ASTM	F 1554	Standard Specification for Anchor Bolts
ASME	B18.2.1	Square and Hex Bolts and Screws
ASME	B18.6.1	Wood Screws
ASME	B18.6.3	Machine Screws and Machine Screw Nuts
ASME	B18.21.1	Lock Washers
ASME	B18.22.1	Plain Washers
AWS	D1.1	Structural Welding Code – Steel
COE	CRD-C620	Specification for Non-Shrink Grout
SSPC	Paint-20	Specification for Zinc Rich Primers, Type I - Inorganic and Type II - Organic

1.3 SUBMITTALS

- A. Submittals shall be made in accordance with the requirements of the General Provisions, and as modified herein.
- B. Manufacturer's product data, anchor details and installation instructions for products to be used in the fabrication of metal work, including paint products and grout. Submit manufacturer's qualification to the Engineer for review.
- C. Shop Drawings showing fabrication and erection of metal fabrications. Include plans, elevations, sections and connection details, as well as anchorage and accessory items, and for custom aluminum assemblies, sealed drawings by an engineer licensed in the State of Missouri. Structural calculations shall be prepared and sealed by a licensed engineer. All relevant design loads shall be considered with load combinations in accordance with ASCE

07-11. The Station shade structures shall be designed for Dead, Roof Live, Snow and Wind as a minimum. An additional 500 pound concentrated roof live load shall also be considered at any point on the roof.

- D. Welding operators' qualification in accordance with AWS "Standard Qualification Procedure".
- E. Welding process qualification certificate per AWS D 1.1.

1.4 QUALITY ASSURANCE/QUALITY CONTROL

- A. Quality assurance/quality control shall be in accordance with the requirements of the General Provisions, and as modified herein.
- B. Assign a task manager to oversee the work of this Section. Submit the task manager's qualification to the Engineer for approval.
- C. Comply with the provisions of the Referenced Standards, except where more stringent requirements are shown or specified.
- D. Take field measurements prior to preparation of Shop Drawings and fabrication.
- E. Furnish inserts and anchoring devices that must be set in concrete or built into masonry for installation of metal work. Coordinate delivery with others to avoid delay and misplacement.
- F. Shop Assembly: Pre-assemble items in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.
- G. Engage manufacturers who have been regularly performed the Work of similar magnitude and scope in last 3 years.
- H. Furnish products of a single manufacturer for each component and process to achieve uniformity.

PART II - PRODUCTS

2.1 MATERIALS

- A. Structural steel shall conform to ASTM A 36.
- B. Structural steel pipe shall conform to ASTM A 53, Type E or Type S.
- C. Structural steel tubing shall conform to ASTM A 500, Grade B, $F_y = 46$ ksi.
- D. Aluminum and Aluminum Alloy Sheet and Plate shall conform to ASTM B 209
- E. Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes shall conform to ASTM B 221
- F. Aluminum-Alloy Extruded Structural Pipe and Tube ASTM B 429
- G. Standard bolts shall conform to ASTM A 307.
- H. High strength bolts shall conform to ASTM A 325, Type N.
- I. High strength tie rods shall be galvanized and shall conform to ASTM A 449.

- J. Tie rod nuts shall be galvanized and shall be heavy hexagon nuts conforming to ASTM A 563, Grade DH.
- K. Direct tension indicators shall be the compressible-washer-type conforming to ASTM F 959.
- L. Galvanizing repair paint shall be high zinc dust content paint for re-galvanizing welds in galvanized steel, with dry film containing not less than 84 percent zinc dust by weight, and complying with SSPC-Paint-20.
- M. Galvanized Chain
1. Description
 - a. Type: Straight Link Machine Chain
 - b. Size: 5/0
 - c. Weight: 52 lbs/100 ft
 - d. Material Diameter: 0.250 in
 - e. Links per foot: 11 ¹/₄
 2. Manufacturer's qualification shall be submitted with product data sheet for review and approval by the Engineer.
- N. Ferrous Metal Surfaces, General: Exposed materials shall be free of pitting, seam marks, roller marks, rolled trade names, roughness, and other variations.
- O. Brackets, Flanges and Anchors: Cast or formed metal of the same type material and finish as supported rails, unless otherwise indicated.
- P. Concrete Inserts: Threaded or wedge type; galvanized ferrous castings, either malleable iron, ASTM A 47, or cast steel, ASTM A 27. Provide bolts, washers, and shims as required, hot-dip galvanized per ASTM A 153.
- Q. Grout and Anchoring Cement
1. Non-shrink Metallic Grout: Premixed, factory-packaged, non-staining, non-corrosive, nongaseous, complying with ASTM C 1107, specifically manufactured for heavy duty loading application.
 2. Submit manufacturer's qualification with product data sheet to the Engineer for review and approval.
- R. Fasteners
1. General: Provide stainless steel, tamperproof fasteners for exterior use or where built into exterior fabrications. Select fasteners for the type, grade, and class required.
 - a. Bolts and Nuts: Regular hexagon head type, ASTM A 307, Grade A, with hex nuts, ASTM A 563.
 - b. Anchor Bolts: ASTM F 1554, Grade 36.
 - c. Lag Screws: ASME B18.2.1
 - d. Machine Screws: ASME B18.6.3.

- e. Wood Screws: Flat head, carbon steel, ASME B18.6.1.
 - f. Plain Washers: Round, carbon steel, ASME B18.22.1.
 - g. Lock Washers: Helical, spring type, carbon steel, ASME B18.21.1.
 - h. Masonry Anchorage Devices: Expansion Shields, CID A-A-1922.
 - i. Drilled-in Expansion Anchors: Anchor bolts and sleeve assembly shall be carbon steel components zinc plated to comply with ASTM B 633, Class Fe/Zn 5, capable to sustain, without failure, load equal to six times load imposed when installed in unit masonry and equal to four times load imposed when installed in concrete determined by testing per ASTM E 488, conducted by qualified independent testing agency.
 - j. Toggle Bolts: Tumble-wing type, FS FF-B-588D (canceled), class, and style as required.
- S. Concrete Fill: Comply with requirements of Section 03300 Cast-In-Place Concrete for normal weight, air entrained, ready mix concrete with min. 28 day compressive strength of 4000 psi.

2.2 FABRICATION

- A. For fabrication of metal work which will be exposed to view, use only materials which are smooth and free of surface blemishes including pitting, seam marks, roller/extrusion marks and rolled trade names.
- B. Shop Fabrication
 - 1. Use steel materials of size and thickness shown or, if not shown, of required size and thickness to produce strength and durability in finished product.
 - 2. Assemble materials to dimensions shown on accepted Shop Drawings, using proven details of fabrication and support.
 - 3. Form exposed work true to line and level with accurate angles and surfaces and straight sharp edges. Ease exposed edges to a radius of approximately $\frac{1}{32}$ inch unless otherwise shown.
 - 4. Form bent metal corners to smallest radius possible without causing grain separation or otherwise impairing Work.
- C. Welds and Anchors
 - 1. Shop weld corners and seams continuously, complying with AWS recommendations.
 - 2. Grind exposed welds smooth and flush, to match and blend with adjoining surfaces.
 - 3. Increase sizes of welds as required to compensate for grinding smooth.
 - 4. Shop form exposed connections with hairline joints, flush and smooth, using concealed fasteners wherever possible.
 - 5. Use exposed fasteners of type shown or, if not shown, socket type flat head (countersunk) screws or bolts.

6. Provide sufficient backing at screw locations to cover at least three threads.
 7. Provide for anchorage of type suitable for use with supporting structure.
 8. Fabricate and space anchoring devices as shown and as required to provide adequate support for intended use.
 9. Cut, reinforce, drill and tap metal Work as required to receive finish hardware.
- D. Galvanizing: Provide a zinc coating for those items shown or specified to be galvanized (unless otherwise noted), as follows, and items at exterior and in exterior walls.
1. ASTM A 153 for galvanizing iron and steel hardware.
 2. ASTM A 123 for galvanizing iron and steel products.
- E. Fabrication of Rough Hardware:
1. Furnish bent or otherwise custom fabricated bolts, plates, anchors, hangers, dowels and other steel, aluminum, and iron shapes as required for framing and supporting Work, and for anchoring or securing Work to substrates.
 2. Fabricate items of sizes, shapes and dimensions required.
- F. Fabrication of Structural Steel Framing: Fabricate shapes and sizes as required for profiles shown. Except as otherwise noted, fabricate units from structural steel shapes and plates and steel bars, with continuously welded joints and smooth exposed edges. Use concealed field splices wherever possible. Provide cutouts, fittings and anchorages as required for coordination of assembly and installation with other Work. Galvanize exterior structural steel.
- G. Fabrication of Loose Bearing Plates: Fabricate loose bearing plates for steel items bearing on concrete and masonry construction, made flat, free from warps or twists, and of required thickness and bearing area. Drill plates to receive anchor bolts and for grouting as required. Galvanize bearing plates after fabrication.
- H. Fabrication of Steel Angles, Support Framing and Pipe Sleeves
1. Fabricate steel angles, support framing and pipe sleeves as required to complete Work. Galvanize items at exterior and in exterior walls.
 2. Fabricate steel support framing units to sizes, shapes, and profiles shown or, if not shown in the drawings, of required dimensions to receive adjacent other Work to be retained by framing. Except as otherwise shown, fabricate framing and sleeves from structural steel shapes, plates and steel bars, of welded construction using mitered joints for field connections. Cut, drill and tap units to receive hardware and similar items.
 3. Fabricate pipe sleeves with integrally welded anchor straps for casting into concrete. Except as otherwise shown, space anchors 24 inches on center and provide minimum steel straps of 1-¹/₄ inches wide by ¹/₄ inch thick by 8 inches long.
- I. Fabrication of Custom Extruded Aluminum Shapes (Base Bid)
1. Fabricate aluminum pipe section to match sizes, shapes and profiles shown in the drawings. Fabricate framing and sleeves from aluminum shapes of welded construction using mitered joints. Where a section is assembled from more than

one part to achieve the section profile, the joints shall be welded or mechanically joined such that the seams, joints, and fasteners are concealed. Cut, drill and tap units to receive conduit, pipe, fasteners, fixtures and similar items.

- J. Allow for thermal movement to prevent buckling, opening up of joints, overstressing of components, failure of connections, and other detrimental effects.

PART III - EXECUTION

3.1 PREPARATION

- A. Examine areas and conditions under which metal fabrications are to be installed. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to installer.
- B. Furnish setting drawings, diagrams, templates, instructions, and directions for installation of anchorages, such as concrete inserts, anchor bolts and steel supporting items having integral anchors, which are to be embedded in concrete or masonry construction. Coordinate delivery of steel supporting items to the work site.
- C. Set sleeves in concrete with tops flush with finish surface elevations; protect sleeves from water and concrete entry.

3.2 INSTALLATION

- A. Fastening to In-Place Construction
 - 1. Provide anchorage devices and fasteners where necessary for securing steel supporting items to in-place construction including threaded fasteners for concrete inserts, toggle bolts, through bolts, and other connectors as required.
- B. Cutting, Fitting and Placement
 - 1. Perform cutting, drilling, and fitting required for installation of steel and aluminum supporting metal items. Set Work accurately in location, alignment and elevation, plumb, level, true and free of rack, measured from established lines and levels with lines visually parallel. Provide temporary bracing or anchors in framework for items that are to be built into concrete or masonry.
 - 2. Fit exposed connections accurately together to form tight hairline joints. Weld connections that are not to be left as exposed joints, but cannot be shop welded because of shipping size limitations. Grind joints smooth and touch-up shop paint coat. Do not weld, cut or abrade the surfaces of exterior units which have been hot-dip galvanized or powder coated after fabrication, and are intended for bolted or screwed field connections.
- C. Field Welding: Comply with AWS Code for procedures of manual shielded metal-arc welding, appearance and quality of welds made, and methods used in correcting welding work.
- D. Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with same material as used for shop painting. Apply by brush or spray to provide a minimum dry film thickness of 1.0 mil.
- E. For galvanized surfaces clean welds, bolted connections and abraded areas and apply galvanizing repair paint as recommended by ASTM A 780.

3.3 SETTING BEARING AND LEVELING PLATES

- A. Clean concrete and masonry bearing surfaces of any bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of bearing plates.
- B. Set loose leveling and bearing plates on wedges, or other adjustable devices. After the bearing members have been positioned and plumbed, tighten the anchor bolts. Do not remove wedges or shims, but if protruding, cut off flush with the edge of the bearing plate before packing with grout.
 - 1. Use metallic non-shrink grout in concealed locations where not exposed to moisture; use nonmetallic non-shrink grout in exposed locations, unless otherwise indicated.
 - 2. Do not place grout when overnight temperatures are expected to drop below freezing, if left unprotected.
 - 3. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.4 ADJUSTING AND CLEANING

- A. For galvanized surfaces clean welds, bolted connections and abraded areas and apply galvanizing repair paint to comply with ASTM A 780.

PART IV - MEASUREMENT

- 4.1 Measurement** – No Separate measurement will be made for Work described in this Section.

PART V - PAYMENT

- 5.1 Payment** – Payment for items in this Section will be incidental to the Contract unit cost of the metal bid items.

END OF SECTION

SECTION 05 50 10
MISCELLANEOUS METAL FABRICATIONS

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Miscellaneous Metal Fabrications, as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

- A. Materials and operations standards:
 - 1. AAMA, Architectural Aluminum Manufacturer's Association.
 - 2. AISC, American Institute of Steel Construction.
 - 3. ASTM, American Society for Testing and Materials.
 - 4. AWS, American Welding Society.
 - 5. NAAMM, National Association of Architectural Metals Manufacturers.

1.3 SUBMITTALS

- A. Shop drawings:
 - 1. Plans and elevations showing all members and connections.
 - 2. Anchors and accessory items.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Materials listed:
 - 1. Base: As noted.
- B. Galvanizing Repair Paint:
 - 1. Base:
 - a. Tnemec.
 - 2. Optional:
 - a. ZRC Worldwide.
 - b. Sherwin-Williams.
- C. Shop Primer:
 - 1. Base:
 - a. As recommended by finish coat manufacturer for substrate.
 - 2. Optional:
 - a. Sherwin-Williams.
 - b. Tnemec.
- D. Non-shrink Grout:
 - 1. Base:
 - a. Dayton Superior Corporation.
 - 2. Optional:
 - a. Sauereisen.
 - b. CGM Building Products (Por-Rok).
- E. Decorative Bollard Covers:
 - 1. Base:

a. Thermoprene.

F. Other manufacturers desiring approval comply with Section 00 26 00.

2.2 MATERIALS

A. Structural steel:

1. Steel, Structural W shapes and tee's: ASTM-A992 (50ksi yield point)
2. Other steel shapes and plate: ASTM-A36
3. Pipe – Round ASTM A53 Grade B
4. Tubing square or rectangular: ASTM-A500, grade-B (46ksi minimum)

B. Cast steel: ASTM-A27, Grade-65-35; and ASTM-A148, Grade-80-50.

C. Steel forgings: ASTM-A668.

D. Bolts: ASTM-A307, ASTM-A325, ASTM-A354.

E. Filler metal: AWS Standards.

F. Cast iron: ASTM-A48, Class 30, minimum 206 850 kPa 30,000 PSI tensile.

G. Malleable iron: ASTM-A47 and ASTM-A197.

H. Aluminum: ASTM-B308 for particular alloy in standard shapes and extrusions, ASTM-B26 for castings.

I. Stainless steel: ASTM-A484 and ASTM-A276.

1. Concealed: Type 302 or Type 304.
2. Exposed: Type 304.
 - a. Finish: ASTM-A480 AISI finish #4, unless otherwise indicated.
3. Exposed: Type 316.
 - a. Finish: ASTM-A480 AISI finish #4, unless otherwise indicated.

J. Anchorage devices - Masonry:

1. Standard manufactured items.
2. Lead expansion shields for machine screws and bolts 1/4 IN and smaller: Head out embedded nut type.
3. For machine screws and bolts larger than 1/4 IN: Manufacturers' standard.
4. Bolt anchor expansion shields for lag bolts: Zinc alloy, long shield anchors.
5. Bolt anchor expansion shields for bolts: Closed end bottom bearing type.
6. Anchor to embed or set device in setting compound or epoxy grout where shown.

K. Fasteners:

1. Galvanized or stainless where built into exterior walls.
2. Select fasteners for type, grade and class required.
3. Bolts and Nuts: Regular hexagon head ASTM-A307, Grade-A.
4. Lag Bolts: Square or octagonal head type.
5. Machine Screws: Cadmium plated steel.
6. Wood Screws: Flat head carbon steel.
7. Plain Washers: Round, carbon steel.
8. Lock Washers: Helical spring carbon steel.

L. Non-shrink grout:

1. Compressive strength: 48.2 MPa 9000 PSI at 7 days.
2. Base Product: 1107 Advantage Grout by Dayton Superior.

M. Abrasive warning tape:

1. Self-adhering, tape with slip resistive mineral surface.
2. Color: Safety Yellow.
3. Width: 2 IN, except where noted otherwise.
4. Tape Type 2:
 - a. Base Product: Safety-Walk 530 Conformable by 3M.

- b. Backing: Aluminum foil.
- c. Thickness: 0.035 IN.
- d. Use Type 2 at top and bottom rungs of all ladders.

2.3 FABRICATION

- A. Form to shapes indicated with straight lines, sharp angles, and smooth curves.
- B. Drill or punch holes with smooth edges for temporary field connections and attachment of work by other trades.
- C. Make permanent shop and field connections with continuous fillet type welds.
- D. Grind exposed welds smooth.
- E. Conceal fastenings where practicable.
- F. Shop fabricate in as large assemblies as practicable.
- G. Meet requirements specified under Structural Steel for fabricating items of structural nature or use.
- H. Qualify welding processes and welding operators in accordance with AWS.

2.4 SURFACE PREPARATION AND SHOP-APPLIED COATINGS

- A. Items not to receive coatings:
 - 1. Surfaces scheduled to be fireproofed with spray-on material.
 - 2. Machined surfaces.
 - 3. Surfaces adjacent to field welds.
 - 4. Contact surfaces of bolt connections at slip connections.
 - 5. Top flanges of beams to receive shear connectors.
 - 6. Items for which no coating or field finish is specified.
- B. Shop Primer for Interior (non-wet) Items:
 - 1. Primer: Coordinate with finish systems specified in Section 09 91 23.
 - 2. Apply primer for interior finish paint to following surfaces not receiving other coating:
 - a. Surfaces exposed on interior.
 - 3. Clean thoroughly before priming; remove mill scale, rust, dirt, oil, and grease in accordance with SSPC-SP3.
 - 4. Apply in accordance with paint manufacturer's instructions.
 - a. Apply minimum 0.002 IN, dry film thickness.
 - 5. Finish Paint (applied in field): Specified in Section 09 91 23.
- C. Hot-dip Galvanized (HDG) Coating for Exterior items:
 - 1. Galvanize (HDG) the following items:
 - a. Items to be installed on site, roof or other areas that are outside of building enclosure walls. This shall include items "attached to" exterior walls of building.
 - b. Items to be installed in wet or humid (>70% RH) areas of building.
 - c. Partial listing of items to receive HDG:
 - 1) Masonry lintels, ledge angles and shelf angles.
 - 2) Pipe Bollards.
 - 3) Exterior Ladders, Stairs and railings.
 - 4) Exterior gratings and substructure.
 - 5) Exterior equipment supports.
 - 6) Similar items which are exposed to weather or built-in to Exterior walls.
 - 7) Other items indicated.
 - 2. Clean thoroughly before galvanizing.
 - 3. Galvanize in accordance with ASTM-A123.
- D. Galvanizing repair coating:
 - 1. Tnemec Series 94-H20 Hydro-Zinc.

2. ZRC Worldwide, Galvilite 221.
3. Sherwin Williams Zinc Clad III HS 100.

2.5 PAINTING

- A. Paint exterior steel items (in field) as Specified in Section 09 91 13.
- B. Paint interior steel items (in field) as Specified in Section 09 91 23.

2.6 METAL FABRICATIONS

- A. General:
 1. Supply items required to complete construction and installation.
 2. Minimum Workmanship Standards (unless noted otherwise): Class 1 (Architectural) per NAAMM AMP-555, Code of Standard Practice for the Architectural Industry.
 3. Anchorage accessories:
 - a. Items required to secure wood to metal, wood to masonry, metals to masonry or concrete, metal to metal or metal to other items.
- B. Ladders:
 1. General:
 - a. Design to comply with the following regulations:
 - 1) ANSI-A14.3.
 - 2) OSHA 29 1910.27.
 - b. Material:
 - 1) Exterior Ladders: Galvanized steel, painted by Section 09 91 13.
 - 2) Interior Ladders: Shop-primed steel, painted by Section 09 91 23.
 - c. Side rail members: Minimum 13 x 1/2 x 2 IN.
 - d. Rungs: Minimum 7/8 IN round or square bars.
 - e. Punch rungs through side rails and weld.
 - f. Size to support concentrated moving load of 200 LB.
 - g. Minimum clearance from centerline of rung to wall or obstruction: 7 IN.
 - h. Minimum ladder width: 16 IN between side rails.
 - i. Rung spacing: 12 IN O.C.
 - j. Apply abrasive warning tape Type 2 to top and bottom rung of all ladders.
 2. Elevator Pit Ladders:
 - a. Comply with general items above, except as amended by following:
 - b. Extend from bottom of pit to 4 FT above floor level.
 - c. Rungs: Minimum 3/4 IN round or square bars.
 - d. Rung clearance: 7 IN from center of rung to face of pit wall.
 - e. Maximum projection from wall: 8 IN or as directed by locally adopted codes and elevator running clearances.
 - f. Comply with ANSI/ASME-A17.1.
 - g. Coordinate final dimensions and locations with Elevator contractor.
 - h. Provide radius edges at tops of all side rails.
- C. Metal Gratings:
 1. Complying with NAAMM Metal Bar Grating Manual.
 2. Material and Thickness (except were otherwise indicated):
 - a. Galvanized steel, nominal 1-1/2 IN thick.
 3. Load Capacity: Support minimum uniform load of 9575 Pa 200 PSF.
 4. Provide hold down clips.
 5. Furnish with frames and support items of comparable material and finish.
- D. Steel Support Angles, Members and Loose Lintels:
 1. ASTM-A36 steel, Sizes and configurations as indicated.
 2. Items to be HDG (galvanized):
 - a. Items to be permanently exposed to weather, high-humidity, or wet conditions.
 - b. Items set into exterior walls.

3. Shop Prime interior items (in non-wet areas).
- E. Miscellaneous Equipment Supports:
1. ASTM A36 steel, Sizes and configurations as indicated.
 2. Examples of items included:
 - a. Supports for Folding Partitions, Operable Walls, Coiling Doors and Grilles.
 - b. Supports for ICU Doors.
 - c. Support of Medical Equipment including Surgical Lights, Power Columns. And other items indicated.
 - d. Ceiling hung toilet partitions.
 - e. Other miscellaneous support items as indicated.
 3. Items to be hot dipped galvanized:
 - a. Items to be permanently exposed to weather, high-humidity, or wet conditions.
 - b. Items set into exterior walls.
 4. Shop Prime interior items (in non-wet areas).

2.7 BOLLARDS

- A. General:
1. Provide where indicated.
 2. Supply items required to complete construction and installation.
 3. Minimum Workmanship Standards (unless noted otherwise): Class 1 (Architectural) per NAAMM AMP-555, Code of Standard Practice for the Architectural Industry.
- B. Type UB-1 (Utility Bollards):
1. 6 IN diameter extra strength, HDG (galvanized), steel pipe.
 2. Length: Unless otherwise indicated; minimum 42 IN projection above ground and 36 IN embedment into concrete.
 3. Fabricate with welded on anchors.
 4. Fill pipe with 3000 PSI concrete with rounded top.
 5. Paint (in-field) by Division 09.
- C. Type DB-1 (Steel Bollards with Decorative Cover):
1. Assembly including a concrete-filled steel pipe with a decorative cover sleeve.
 2. Steel pipe bollard:
 - a. 6 IN diameter extra strength, HDG (galvanized), steel pipe.
 - b. Length: Unless otherwise indicated; minimum 42 IN projection above ground and 36 IN embedment into concrete.
 - c. Fabricate with welded on anchors.
 - d. Fill with 3000 PSI concrete, flush at top.
 3. Decorative Bollard Covers:
 - a. Description: 1/8 IN thick, HDPE.
 - b. Size as appropriate for pipe.
 - c. Color: To be selected by Architect.
 - 1) 5-year warranty for color-fastness, cracking and UV-resistance.
 - d. Dual reflective stripes near top of cover.
 - e. Base Product: Bollardgard by Thermoprene.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Verify suitability of substrate to accept installation.
- B. Installation constitutes acceptance of responsibility for performance.
- C. Ensure that adequate Wall Backing (as specified in Section 09 22 16) has been installed where required for wall-mounted items specified in this Section.

3.2 INSTALLATION

- A. General:
 - 1. Set work level, true to line, plumb.
 - 2. Shim and grout as necessary.
 - 3. Weld field connections and grind smooth.
 - 4. Where practical, conceal fastenings.
 - 5. Secure metal to wood with lag screws of adequate size with appropriate washers.
 - 6. Secure metal to concrete with embedded anchors, setting compounds, caulking and sleeves, or setting grout.
 - a. Use expansion bolts, toggle bolts, or screws for light duty service.
 - 7. Meet structural requirements for erecting items of structural nature.
 - 8. Do not field splice fabricated items unless size requires splicing.
 - 9. Weld splices.
 - 10. Provide fabricated items complete with attachment devices as required to install.
- B. Galvanic Repair:
 - 1. After galvanized units have been erected and anchored apply galvanizing repair paint in accordance with manufacturer's recommendations.
 - 2. Surface preparation: Remove contaminates in accordance with SSPC SP-1.
- C. Bollards:
 - 1. Direct-buried: Prepare hole in earth which is at least:
 - a. Hole Depth: 6 IN deeper than embedment length specified for bollard.
 - b. Hole Diameter: 24 IN diameter for 150mm 6 IN diameter pipes.
 - c. Set pipe bollards plumb and to the exposure height indicated.
 - 2. Surface-Bolted and other means of attachment: Install as detailed.
 - 3. Fill annular space with concrete fill having a compressive strength of at least 20,685 kPa 3000 PSI.
 - 4. Paint or cover with decorative sleeves as scheduled.

END OF SECTION

SECTION 05 50 13 STEEL STAIRS AND RAILINGS

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Steel Stairs and Railings, as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

- A. Code Compliance:
 - 1. Conform to applicable Building Codes.
 - 2. Use most restrictive requirements of NFPA, IBC, ADA Standards of Accessible Design or other codes or amendments adopted by local Authority Having Jurisdiction.
- B. Design Responsibility:
 - 1. Engineering design submittal must be performed by, or under direct supervision of, a registered Professional Engineer, licensed to practice Structural Engineering in State of Missouri.
 - 2. Submittal must include calculations for all load-bearing components of stairs and landings.
 - a. Indicate design live loads on submittal.
 - 3. Submittal to be reviewed by Architect for general conformance with design intent shown by Contract Documents.
 - a. Physical adequacy of Structural design and conformance with applicable building Codes are responsibility of stair fabricator.
- C. Materials and Design Standards:
 - 1. American Institute of Steel Construction (AISC).
 - 2. ASTM International (ASTM).
 - 3. American Welding Society (AWS).
 - 4. National Association of Architectural Metals Manufacturers (NAAMM).
 - 5. National Ornamental & Miscellaneous Metals Association (NOMMA).
- D. Workmanship Standards:
 - 1. Fabricate in accordance with latest editions of NAAMM AMP 521, Pipe Railings Systems Manual, and NAAMM AMP-510, Metal Stairs Manual.
 - 2. Railing System Joints: Continuous fillet weld. Type 1 Railing System Joint Construction.

1.3 SUBMITTALS

- A. Shop Drawings:
 - 1. Layout drawings indicating rise and run.
 - 2. Include full sections, details, handrails, guardrails and anchoring methods.
- B. Project Information:
 - 1. Engineering calculations indicating design moments, shears, and other forces sealed by registered Engineer, licensed to practice Structural Engineering in the State of MO.
 - a. Submit concurrent with Shop Drawings.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Steel Stairs:
 - 1. Shop fabricated.
- B. Galvanizing Repair Paint:
 - 1. Base:
 - a. Tnemec.
 - 2. Optional:
 - a. ZRC Worldwide.
 - b. Sherwin-Williams.
- C. Shop Primer:
 - 1. Base:
 - a. As recommended by finish coat manufacturer for substrate.
 - 2. Optional:
 - a. Sherwin-Williams.
 - b. Tnemec.
- D. Non-shrink Grout:
 - 1. Base:
 - a. Dayton Superior Corporation.
 - 2. Optional:
 - a. Sauereisen.
 - b. CGM Building Products (Por-Rok).
- E. Abrasive Warning Tape:
 - 1. Base:
 - a. 3M.
- F. Other manufacturers desiring approval comply with Section 00 26 00.

2.2 MATERIALS

- A. Structural steel: ASTM A36, ASTM A501, ASTM A575 or ASTM A108.
- B. Cast steel: ASTM A27, Grade-65-35; and ASTM A148, Grade-80-50.
- C. Steel forgings: ASTM A668.
- D. Bolts: ASTM A307, ASTM A325, ASTM A354.
- E. Filler metal: AWS Standards.
- F. Malleable iron: ASTM A47 and ASTM A197.
- G. Steel pipe: ASTM A53.
- H. Non-shrink Grout:
 - 1. Compressive strength: 41,370 kPa 6,000 PSI at 7 days.
 - 2. Base Product: 1107 Advantage Grout by Dayton Superior Corporation.
- I. Anchorage Devices:
 - 1. Items required to secure wood to metal, wood to masonry, metals to masonry, or concrete, metal-to-metal or metal to other items.
 - 2. Galvanized or stainless where built into exterior walls.
 - 3. Select fasteners for type, grade, and class required.
 - 4. Bolts and Nuts: Regular hexagon head ASTM A307, Grade A.
 - 5. Lag Bolts: Square or octagonal head type.
 - 6. Machine Screws: Cadmium plated steel.
 - 7. Wood Screws: Flat head carbon steel.

8. Plain Washers: Round, carbon steel.
9. Lock Washers: Helical spring carbon steel.
10. Lead expansion shields for machine screws and bolts 1/4 IN and smaller: Head out embedded nut type.
 - a. For machine screws and bolts larger than 1/4 IN: Manufacturers' standard.
 - b. Bolt anchor expansion shields for lag bolts: Zinc alloy, long shield anchors.
 - c. Bolt anchor expansion shields for bolts: Closed end bottom bearing type.

2.3 STEEL STAIRS

- A. Design, fabricate, and install in compliance with applicable codes.
 1. Enclosed Stairs: Commercial Class per latest edition NAAMM AMP-510, Metal Stairs Manual.
 2. Non-enclosed and monumental stairs: Architectural Class per latest edition NAAMM AMP-510, Metal Stairs Manual.
- B. Fabricate and design stair and landing assembly to support larger of following loads, whichever results in strongest components:
 1. Design Concentrated Moving Load: 136 KG 300 LBS.
 2. Design Uniform Load: 4790 Pa 100 PSF.
- C. Support stairs at locations indicated.
- D. Hangers: Minimum 1/2 IN diameter steel rod.
 1. Connect hangers to beams only.
 2. Hanger-slab connections are not permitted.
 3. Maximum eccentricity from beam centerline to hanger centerline shall be 2 IN.
 4. Connect hangers to structure with through-bolt type connections when in tension.
 - a. Recess top plate and nut in slab and grout smooth.
 5. Expansion anchor type connections in tension are not allowed.
- E. Support brackets and posts:
 1. Attach to structure as required, use welded connections whenever possible.
 2. When required, expansion anchors in concrete shall only be used for shear type connections.
- F. Stringers:
 1. Channel shape: 3/16 IN x 12 IN deep steel plate, minimum.
 2. Outside stringers shall span flight length plus landing.
 - a. Intermediate supports are not allowed without prior approval.
- G. Treads:
 1. Minimum 14 GA steel pans with angle supports as required.
- H. Risers:
 1. Minimum 14 GA steel.
- I. Landings:
 1. Minimum 10 GA pans with angle supports as required.
- J. Metal Lath:
 1. Self-furring diamond mesh with dimples or embossed ribs.
 2. Maintain metal lath, 1/4 IN minimum, above tread and landing steel pans.
- K. Form surface with slip resistant materials: See Section 03 35 00.
- L. Apply abrasive warning tape Type 1 to first and last nosing, at top and bottom, of stair runs.
- M. Contractor's option: Provide factory manufactured stair system in lieu of fabricated stairs, subject to review by Architect.

2.4 HANDRAILS AND GUARDRAILS

- A. Design Criteria:
 - 1. Comply with building codes and amendments.
 - 2. Utilize following loads for design of indicated members and their direct or indirect connection to building superstructure.
 - a. Handrails and top rail of Guardrails, Uniform Load: 50 LBS/LF minimum applied in any direction.
 - b. Handrails, Concentrated Load: 200 LBS minimum applied in any direction at any point along rail.
 - c. Guardrail, Concentrated Load: 200 LBS minimum applied in any direction at any point along rail.
 - d. Uniform and concentrated loads need not be concurrently applied.
 - 3. Intermediate rails, balusters, panels, and other infill materials:
 - a. Design to withstand a horizontal applied normal load of 50 LBS minimum on an area not to exceed 1 SF including openings and space between rails.
 - 4. Form to profiles indicated.
- B. Rails to be installed on exterior:
 - 1. Apply hot-dip galvanized (HDG) coating to steel after all rails which will be installed in exterior locations.
 - 2. Apply HDG coating after all cutting, drilling, grinding, welding and other fabrication has been completed.
- C. Handrails -General:
 - 1. Minimum clearance from wall: 1-1/2 IN.
 - 2. Maximum projection from wall: 4-1/2 IN.
 - 3. Maximum span between mounting brackets and/or newel posts: 8 FT.
 - 4. Return ends of wall mounted rails to wall.
- D. Make rails smooth with no projections to prevent a hand from sliding along entire length.
- E. Handrail Member Size:
 - 1. Round Tube: HSS 1.50.x 0.083; ASTM A500.
- F. Guardrail Member Sizes - General:
 - 1. Following member sizes are minimum.
 - 2. Sizes shall be increased where appropriate to resist design loads.
 - 3. Refer to drawings for depiction of guardrails.
 - 4. Maximum span between mounting brackets and newel posts: 8 FT.
- G. Newel Posts:
 - 1. Definition: Vertical elements at terminal ends of a guardrail panels; means by which Guardrail panels are attached to floors, stringers and other structural elements.
 - 2. Round Tube: HSS 1.66.x 0.140; ASTM A500 or as required to resist loads and spacing as shown on Architectural drawings.
- H. Top Rails and Bottom Rails:
 - 1. Definition: Top and bottom elements spanning the length of a Guardrail panel and terminated by Newel Posts.
 - 2. Round Tube: HSS 1.66.x 0.140; ASTM A500.
- I. Balusters/Pickets:
 - 1. Definition: Vertical elements spanning between Top Rails and Bottom Rails in a Guardrail panel; Used to subdivide panel.
 - 2. Square Bar: 1/2 x 1/2 IN.

2.5 MISCELLANEOUS ITEMS

- A. Abrasive Warning Tape:

1. Self-adhering, tape with slip resistive mineral surface.
2. Color: Safety Yellow.
3. Width: 2 IN, except where noted otherwise.
4. Tape Type 1:
 - a. Base Product: Safety-Walk 630 General Purpose Tread by 3M.
 - b. Backing: Plastic film.
 - c. Thickness: 0.70.030 IN.
 - d. Use Type 1 at first and last stair nosings of all stair runs.
 - 1) Do not use where rubber stair treads or carpet is scheduled.

2.6 FABRICATION

- A. Form to shapes indicated with straight lines, sharp angles, and smooth curves.
- B. Drill or punch holes with smooth edges for temporary field connections and attachment by work of other trades.
- C. Qualify welding processes and welding operators in accordance with American Welding Society.
- D. Make permanent shop and field connections with continuous fillet type welds.
- E. Grind exposed welds smooth and blend seamlessly into pipe.
- F. Conceal fastenings where practicable.
- G. Shop fabricate in as large assemblies as practicable.
- H. Meet requirements specified under Structural Steel for fabricating items of structural nature or use.

2.7 SURFACE PREPARATION AND SHOP APPLIED COATINGS

- A. General:
 1. All items in this section shall be shop finished by one of methods described in this Article.
- B. Shop Primer for Interior (non-wet) Items:
 1. Primer: Coordinate with finish systems specified in Section 09 91 23.
 2. Apply primer for interior finish paint to following surfaces not receiving other coating:
 - a. Surfaces exposed on interior.
 3. Clean thoroughly before priming; remove mill scale, rust, dirt, oil, and grease in accordance with SSPC-SP3.
 4. Apply in accordance with paint manufacturer's instructions.
 - a. Apply minimum 0.002 IN, dry film thickness.
- C. Finish Paint:
 1. Applied in field specified in Section 09 91 23.
- D. Hot-dip Galvanized (HDG) Coating for Exterior and interior wet items:
 1. Galvanize following items:
 - a. Items to be installed on site, roof or other areas that are outside of building enclosure walls. This shall include items attached to exterior walls of building.
 - b. Items to be installed in wet or humid, greater than 70 percent RH, areas of building.
 2. Clean thoroughly before galvanizing.
 3. Galvanize in accordance with ASTM A123.
- E. Galvanizing repair coating:
 1. Tnemec Series 94-H20 Hydro-Zinc.
 2. ZRC Worldwide, Galvilite 221.
 3. Sherwin Williams Zinc Clad III HS 100.

2.8 PAINTING

- A. Paint exterior steel items in field as Specified in Section 09 91 13.
- B. Paint interior steel items in field as Specified in Section 09 91 23.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Verify suitability of substrate to accept installation.
- B. Installation constitutes acceptance of responsibility for performance.
- C. Ensure that adequate wall backing has been installed where required for handrails and similar wall-mounted items specified in this Section.

3.2 INSTALLATION

- A. General:
 - 1. Shim and grout as required to set work plumb, level, and true to line.
 - 2. Weld field connections and grind smooth.
 - 3. Where practical, conceal fastenings.
 - 4. Secure metal to wood with lag screws and washers.
 - 5. Secure metal to concrete with embedded anchors, setting compounds, caulking and sleeves, or setting grout.
 - 6. Meet design requirements for erecting structural components.
 - 7. Do not field splice fabricated items unless size requires splicing.
 - 8. Weld splices and grind smooth.
 - 9. Provide fabricated items complete with attachment devices as required to install.
- B. Galvanic Repair:
 - 1. Repair abraded areas with galvanizing paint in accordance with manufacturer's recommendations.
 - 2. Surface preparation: Remove contaminates in accordance with SSPC SP-1.
- C. Handrails:
 - 1. Furnish handrails complete with brackets.
 - 2. Coordinate locations and installation of wall backing.
 - 3. Where posts are indicated to be set in sleeves, provide galvanized steel sleeves having a minimum wall thickness of 1/8 IN.
 - 4. Set newels or balusters in sleeves with non-shrink grout.
 - 5. Where setting is required for exterior, hold non-shrink grout back 1/4 IN from surface and fill flush with self leveling sealant.
- D. Abrasive warning tapes:
 - 1. Tape application to be installed immediately prior to Substantial Completion.
 - 2. Clean and prepare surfaces to receive tape prior to application.
 - 3. Apply tape in accordance with manufacturer's instructions.
 - 4. Where tape is damaged by construction activities, remove, clean, and reapply new material.

END OF SECTION

SECTION 05 51 19**METAL GRATING STAIRS****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section Includes:

1. Industrial-type stairs with steel grating treads.

- B. Related Sections:

1. Section 05 50 13 "Steel Stairs and Railings" for metal stairs and railings.
2. Section 05 52 13 "Steel Tube Railings" for railings attached to metal grating stairs.

1.03 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design metal stairs, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

- B. Structural Performance of Stairs: stairs shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated.

1. Uniform Load: 100 lbf/ft.
2. Concentrated Load: 300 lbf applied on an area of 4 sq. in.
3. Uniform and concentrated loads need not be assumed to act concurrently.
4. Stair Framing: Capable of withstanding stresses resulting from railing loads in addition to loads specified above.
5. Limit deflection of treads, platforms, and framing members to L/240 or 1/4 inch, whichever is less.

- C. Structural Performance of Railings: Railings shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated.

1. Handrails and Top Rails of Guards:

- a. Uniform load of 50 lbf/ft. applied in any direction.
- b. Concentrated load of 200 lbf applied in any direction.
- c. Uniform and concentrated loads need not be assumed to act concurrently.

2. Infill of Guards:

- a. Concentrated load of 50 lbf applied horizontally on an area of 1 sq. ft.
- b. Infill load and other loads need not be assumed to act concurrently.

- D. Seismic Performance: Metal stairs shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. Component Importance Factor is 1.5.

1.04 SUBMITTALS

- A. Product Data: For metal stairs and the following:
 1. Nonslip aggregates and nonslip-aggregate finishes.
 2. Dimple plate nosings.
 3. Paint products.
 4. Grout.
- B. LEED Submittals:
 1. Product Data for Credit MR 4.1 and Credit MR 4.2. Indicating percentages by weight of postconsumer and preconsumer recycled content for products having recycled content. Include statement indicating costs for each product having recycled content.
- C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
- D. Samples for Initial Selection: For products involving selection of color, texture, or design.
- E. Samples for Verification: For the following products, in manufacturer's standard sizes:
 1. Stair treads with nonslip-aggregate surface finish.
 2. Grating treads.
 3. Dimple plate nosings.
- F. Delegated-Design Submittal: For installed products indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- G. Qualification Data: For qualified professional engineer.
- H. Welding certificates.
- I. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers certifying that shop primers are compatible with topcoats.
- J. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for stairs and railings.
 1. Test railings according ASTM E 894 and ASTM E 935.

1.05 QUALITY ASSURANCE

- A. Installer Qualifications: Fabricator of products.
- B. NAAMM Stair Standard: Comply with "Recommended Voluntary Minimum Standards for Fixed Metal Stairs" in NAAMM AMP 510, "Metal Stairs Manual," for class of stair designated, unless more stringent requirements are indicated.
 1. Industrial-Type Stairs: Industrial class.
- C. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

- D. Welding Qualifications: Qualify procedures and personnel according to the following:
1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
 2. AWS D1.3, "Structural Welding Code - Sheet Steel."

1.06 COORDINATION

- A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.
- B. Coordinate installation of anchorages for metal stairs. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.
- C. Coordinate locations of hanger rods and struts with other work so that they will not encroach on required stair width and will be within the fire-resistance-rated stair enclosure.

PART 2 - PRODUCTS

2.01 METALS, GENERAL

- A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For components exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

2.02 FERROUS METALS

- A. Recycled Content of Steel Products: Provide products with average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent.
- B. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
- C. Steel Tubing: ASTM A 500 (cold formed) or ASTM A 513.
- D. Steel Bars for Grating Treads: ASTM A 36/A 36M or steel strip, ASTM A 1011/A 1011M or ASTM A 1018/A 1018M.

2.03 DIMPLE PLATE NOSINGS

- A. Basis of Design: Subject to compliance with requirements, provide dimple plate nosings by Amico, a Gibraltar Industries Company.
1. Configuration: Manufacturer's standard dimple plate.

2.04 FASTENERS

- A. General: Provide zinc-plated fasteners with coating complying with ASTM B 633 or [ASTM F 1941](#), Class Fe/Zn 12 for exterior use, and Class Fe/Zn 5 where built into exterior walls. Select fasteners for type, grade, and class required.
- B. Bolts and Nuts: Regular hexagon-head bolts, [ASTM A 307, Grade A](#); with hex nuts, [ASTM A 563](#); and, where indicated, flat washers.

- C. Anchor Bolts: ASTM F 1554, Grade 36, of dimensions indicated; with nuts, [ASTM A 563](#); and, where indicated, flat washers.
 - 1. Provide mechanically deposited or hot-dip, zinc-coated anchor bolts for stairs indicated to be galvanized.
- D. Plain Washers: Round, [ASME B18.22.1](#).
- E. Lock Washers: Helical, spring type, [ASME B18.21.1](#).
- F. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.
 - 1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B 633 or [ASTM F 1941](#), Class Fe/Zn 5, unless otherwise indicated.
 - 2. Material for Exterior Locations and Where Stainless Steel is Indicated: Alloy Group 1 stainless-steel bolts, [ASTM F 593](#), and nuts, [ASTM F 594](#).

2.05 MISCELLANEOUS MATERIALS

- A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
- B. Shop Primers: Provide primers that comply with Division 09 painting Sections.
- C. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
- D. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.
- E. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.

2.06 FABRICATION, GENERAL

- A. Provide complete stair assemblies, including metal framing, hangers, struts, clips, brackets, bearing plates, and other components necessary to support and anchor stairs and platforms on supporting structure.
 - 1. Join components by welding unless otherwise indicated.
 - 2. Use connections that maintain structural value of joined pieces.
 - 3. Fabricate treads and platforms of exterior stairs so finished walking surfaces slope to drain.
- B. Preassembled Stairs: Assemble stairs in shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.
- C. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately [1/32 inch](#) unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- D. Form bent-metal corners to smallest radius possible without causing grain separation

or otherwise impairing work.

- E. Form exposed work with accurate angles and surfaces and straight edges.
- F. Weld connections to comply with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. Weld exposed corners and seams continuously unless otherwise indicated.
- G. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) screws or bolts unless otherwise indicated. Locate joints where least conspicuous.
- H. Fabricate joints that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

2.07 STEEL-FRAMED STAIRS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Alfab, Inc.
 - 2. American Stair, Inc.
 - 3. Ohio Gratings, Inc.
 - 4. Sharon Companies Ltd. (The).
- B. Stair Framing:
 - 1. Fabricate stringers of steel plates or channels.
 - a. Provide closures for exposed ends of channel stringers.
 - 2. Construct platforms of steel plate or channel headers and miscellaneous framing members as needed to comply with performance requirements.
 - 3. Weld or bolt stringers to headers; weld or bolt framing members to stringers and headers. If using bolts, fabricate and join so bolts are not exposed on finished surfaces.
 - 4. Where stairs are enclosed by gypsum board assemblies, provide hanger rods or struts to support landings from floor construction above or below. Locate hanger rods and struts where they will not encroach on required stair width and will be within the fire-resistance-rated stair enclosure.
 - 5. Where masonry walls support metal stairs, provide temporary supporting struts designed for erecting steel stair components before installing masonry.
- C. Metal Bar-Grating Stairs: Form treads and platforms to configurations shown from metal bar grating; fabricate to comply with NAAMM MBG 531, "Metal Bar Grating Manual."
 - 1. Fabricate treads and platforms from welded or pressure-locked steel grating with 1-1/4-by-3/16-inch bearing bars at 15/16 inch o.c. and crossbars at 4 inches o.c.
 - 2. Fabricate treads and platforms from welded or pressure-locked steel grating with openings in gratings no more than 5/16 inch in least dimension.
 - 3. Surface: Serrated.

4. Finish: Shop primed.
5. Fabricate grating treads with cast abrasive nosing and with steel angle or steel plate carrier at each end for stringer connections. Secure treads to stringers with bolts.
6. Fabricate grating platforms with nosing matching that on grating treads. Provide toeplates at open-sided edges of grating platforms. Weld grating to platform framing.

2.08 STAIR RAILINGS

- A. Decorative I railings as specified in 05 73 00 "Decorative Metal Railings:"

2.09 FINISHES

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Finish metal stairs after assembly.
- C. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A 153/A 153M for steel and iron hardware and with ASTM A 123/A 123M for other steel and iron products.
 1. Fill vent and drain holes that will be exposed in finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

- A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing metal stairs to in-place construction. Include threaded fasteners for concrete and masonry inserts, through-bolts, lag bolts, and other connectors.
- B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal stairs. Set units accurately in location, alignment, and elevation, measured from established lines and levels and free of rack.
- C. Install metal stairs by welding stair framing to steel structure or to weld plates cast into concrete unless otherwise indicated.
- D. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.
- E. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.
- F. Field Welding: Comply with requirements for welding in "Fabrication, General" Article.
- G. Place and finish concrete fill for treads and platforms to comply with Division 03 Section "Cast-in-Place Concrete."
 1. Install abrasive nosings with anchors fully embedded in concrete. Center

nosings on tread width.

3.02 INSTALLING METAL STAIRS WITH GROUTED BASEPLATES

- A. Clean concrete and masonry bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of baseplates.
- B. Set steel stair baseplates on wedges, shims, or leveling nuts. After stairs have been positioned and aligned, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with grout.
 - 1. Use nonmetallic, nonshrink grout unless otherwise indicated.
 - 2. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.03 ADJUSTING AND CLEANING

- A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
 - 1. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.
- B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

END OF SECTION 05 51 19

SECTION 05 52 14**STEEL PIPE RAILINGS****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section includes:

- 1. Steel pipe railings for metal grating stairs and guardrails at locations indicated.
 - 2. Chain closures.

- B. Related Requirements:

- 1. Section 05 50 13 "Steel Stairs and Railings" for railings associated with metal pan stairs.
 - 2. Section 05 51 19 "Metal Grating Stairs" for stairs associated with Steel Pipe Railings.

1.03 COORDINATION

- A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.
- B. Coordinate installation of anchorages for railings. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.
- C. Schedule installation so wall attachments are made only to completed walls. Do not support railings temporarily by any means that do not satisfy structural performance requirements.

1.04 ACTION SUBMITTALS

- A. Product Data: For the following:

- 1. Manufacturer's product lines of mechanically connected railings.
 - 2. Railing brackets.
 - 3. Grout, anchoring cement, and paint products.

- B. LEED Submittals:

- 1. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.

- C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

- D. Samples: For each type of exposed finish required.
 - 1. Sections of each distinctly different linear railing member, including handrails, top rails, posts, and balusters.
 - 2. Fittings and brackets.
 - 3. Assembled Sample of railing system, made from full-size components, including top rail, post, handrail, and infill. Sample need not be full height.
 - a. Show method of connecting and finishing members at intersections.
- E. Delegated-Design Submittal: For railings, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.05 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified professional engineer.
- B. Welding certificates.
- C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers certifying that shop primers are compatible with topcoats.
- D. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, according to ASTM E 894 and ASTM E 935.
- E. Evaluation Reports: For post-installed anchors, from ICC-ES.

1.06 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

1.08 FIELD CONDITIONS

- A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Steel Pipe and Tube Railings:
 - a. Pisor Industries, Inc.
 - b. Sharpe Products.
 - c. Wagner, R & B, Inc.; a division of the Wagner Companies.

2.02 PERFORMANCE REQUIREMENTS

- A. General: In engineering railings to withstand structural loads indicated, determine allowable design working stresses of railing materials based on the following:
1. Steel: 72 percent of minimum yield strength.
- B. Structural Performance: Provide railings capable of withstanding the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
1. Handrails:
 - a. Uniform load of 50 lbf/ ft. applied in any direction.
 - b. Concentrated load of 200 lbf applied in any direction.
 - c. Uniform and concentrated loads need not be assumed to act concurrently.
 2. Top Rails of Guards:
 - a. Uniform load of 50 lbf/ ft. applied in any direction.
 - b. Concentrated load of 200 lbf applied in any direction.
 - c. Uniform and concentrated loads need not be assumed to act concurrently.
 3. Infill of Guards:
 - a. Concentrated load of 50 lbf applied horizontally on an area of 1 sq. ft..
 - b. Infill load and other loads need not be assumed to act concurrently.
- C. Thermal Movements: Provide exterior railings that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.
- D. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

2.03 METALS, GENERAL

- A. Metal Surfaces, General: Provide materials with smooth surfaces, without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.
- B. Brackets, Flanges, and Anchors: Cast or formed metal of same type of material and finish as supported rails unless otherwise indicated.
1. Provide type of bracket with flange tapped for concealed anchorage to threaded hanger bolt and that provides 1-1/2-inch clearance from inside face of handrail to finished wall surface.

2.04 STEEL AND IRON

- A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
- B. Tubing: ASTM A 500 (cold formed) or ASTM A 513.
 - 1. Provide galvanized finish.
- C. Plates, Shapes, and Bars: ASTM A 36/A 36M.
- D. Cast Iron: Either gray iron, ASTM A 48/A 48M, or malleable iron, ASTM A 47/A 47M, unless otherwise indicated.

2.05 FASTENERS

- A. General: Provide the following:
 - 1. Steel Railings: Plated steel fasteners complying with ASTM B 633, Class Fe/Zn 25 for electrodeposited zinc coating.
- B. Fasteners for Anchoring Railings to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring railings to other types of construction indicated and capable of withstanding design loads.
- C. Fasteners for Interconnecting Railing Components:
 - 1. Provide concealed fasteners for interconnecting railing components and for attaching them to other work, unless exposed fasteners are unavoidable or are the standard fastening method for railings indicated.
- D. Anchors: Provide cast-in-place or torque-controlled expansion anchors, fabricated from corrosion-resistant materials with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry and equal to four times the load imposed when installed in concrete, as determined by testing per ASTM E 488 conducted by a qualified independent testing agency.

2.06 MISCELLANEOUS MATERIALS

- A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
- B. Etching Cleaner for Galvanized Metal: Complying with MPI#25.
- C. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
- D. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187/D 1187M.
- E. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.
- F. Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with water at Project site to create pourable anchoring, patching, and grouting compound.
 - 1. Water-Resistant Product: At exterior locations and where indicated provide formulation that is resistant to erosion from water exposure without needing

protection by a sealer or waterproof coating and that is recommended by manufacturer for exterior use.

2.07 FABRICATION

- A. General: Fabricate railings to comply with requirements indicated for design, dimensions, member sizes and spacing, details, finish, and anchorage, but not less than that required to support structural loads.
- B. Shop assemble railings to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.
- C. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately $1/32$ inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- D. Form work true to line and level with accurate angles and surfaces.
- E. Fabricate connections that are exposed to weather in a manner that excludes water. Provide weep holes where water may accumulate.
- F. Cut, reinforce, drill, and tap as indicated to receive finish hardware, screws, and similar items.
- G. Connections: Fabricate railings with either welded or nonwelded connections unless otherwise indicated.
- H. Welded Connections: Cope components at connections to provide close fit, or use fittings designed for this purpose. Weld all around at connections, including at fittings.
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove flux immediately.
 - 4. At exposed connections, finish exposed surfaces smooth and blended so no roughness shows after finishing and welded surface matches contours of adjoining surfaces.
- I. Nonwelded Connections: Connect members with concealed mechanical fasteners and fittings. Fabricate members and fittings to produce flush, smooth, rigid, hairline joints.
 - 1. Fabricate splice joints for field connection using an epoxy structural adhesive if this is manufacturer's standard splicing method.
- J. Form Changes in Direction as follows.
 - 1. By bending or by inserting prefabricated elbow fittings.
- K. For changes in direction made by bending, use jigs to produce uniform curvature for each repetitive configuration required. Maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.
- L. Close exposed ends of railing members with prefabricated end fittings.

- M. Provide wall returns at ends of wall-mounted handrails unless otherwise indicated. Close ends of returns unless clearance between end of rail and wall is $\frac{1}{4}$ inch or less.
- N. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, flanges, miscellaneous fittings, and anchors to interconnect railing members to other work unless otherwise indicated.
 - 1. At brackets and fittings fastened to plaster or gypsum board partitions, provide crush-resistant fillers or other means to transfer loads through wall finishes to structural supports and prevent bracket or fitting rotation and crushing of substrate.
- O. Gate Hinges: Install two hinges minimum per gate. Space 8-inches from bottom and top of gate. Install additional hinges as required to limit intermediate spacing at not more than 24-inches o.c.
- P. Gate Locking Hardware: Install one bottom lock on each gate. Install one top lock on each single or pair of gates.
- Q. Provide inserts and other anchorage devices for connecting railings to concrete or masonry work. Fabricate anchorage devices capable of withstanding loads imposed by railings. Coordinate anchorage devices with supporting structure.
- R. For railing posts set in concrete, provide steel sleeves not less than 6 inches long with inside dimensions not less than $\frac{1}{2}$ inch greater than outside dimensions of post, with metal plate forming bottom closure.
- S. Toe Boards: Where indicated, provide toe boards at railings around openings and at edge of open-sided floors and platforms. Fabricate to dimensions and details indicated.
- T. Safety Chain Closures: Provide plastic-coated Traffic Red RAL 3020 chain closures at locations shown on Drawings.

2.08 STEEL AND IRON FINISHES

- A. Galvanized Railings:
 - 1. Hot-dip galvanize steel railings, including hardware, after fabrication.
 - 2. Comply with ASTM A 123/A 123M for hot-dip galvanized railings.
 - 3. Comply with ASTM A 153/A 153M for hot-dip galvanized hardware.
 - 4. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion for railings to receive fluoropolymer coatings.
 - 5. Fill vent and drain holes that are exposed in the finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.
- B. For galvanized railings, provide hot-dip galvanized fittings, brackets, fasteners, sleeves, and other ferrous components.
- C. Preparing Galvanized Railings for Shop Priming: After galvanizing, thoroughly clean railings of grease, dirt, oil, flux, and other foreign matter, and treat with etching cleaner.
- D. Primer Application: Apply shop primer to prepared surfaces of railings unless otherwise indicated. Comply with requirements in SSPC-PA 1, "Shop, Field, and Maintenance Painting of Steel," for shop painting. Primer need not be applied to surfaces to be embedded in concrete or masonry.

1. Shop prime uncoated railings with universal shop primer.
- E. Shop-Painted Finish: Comply with Section 09 96 00 "High-Performance Coatings."
 1. Color: As selected by Architect from manufacturer's full range.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine gypsum board assemblies, where reinforced to receive anchors, to verify that locations of concealed reinforcements are clearly marked for Installer. Locate reinforcements and mark locations if not already done.

3.02 INSTALLATION, GENERAL

- A. Fit exposed connections together to form tight, hairline joints.
- B. Perform cutting, drilling, and fitting required for installing railings. Set railings accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.
 1. Do not weld, cut, or abrade surfaces of railing components that are coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.
 2. Set posts plumb within a tolerance of **1/16 inch in 3 feet**.
 3. Align rails so variations from level for horizontal members and variations from parallel with rake of steps and ramps for sloping members do not exceed **1/4 inch in 12 feet**.
- C. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.
- D. Adjust railings before anchoring to ensure matching alignment at abutting joints.
- E. Fastening to In-Place Construction: Use anchorage devices and fasteners where necessary for securing railings and for properly transferring loads to in-place construction.

3.03 RAILING CONNECTIONS

- A. Nonwelded Connections: Use mechanical or adhesive joints for permanently connecting railing components. Seal recessed holes of exposed locking screws using plastic cement filler colored to match finish of railings.
- B. Welded Connections: Use fully welded joints for permanently connecting railing components. Comply with requirements for welded connections in "Fabrication" Article whether welding is performed in the shop or in the field.
- C. Expansion Joints: Install expansion joints at locations indicated but not farther apart than required to accommodate thermal movement. Provide slip-joint internal sleeve extending **2 inches** beyond joint on either side, fasten internal sleeve securely to one side, and locate joint within **6 inches** of post.

3.04 ANCHORING POSTS

- A. For posts indicated to be installed in concrete, use steel pipe sleeves preset and anchored into concrete for installing posts. After posts have been inserted into sleeves, fill annular space between post and sleeve with nonshrink, nonmetallic grout, mixed and placed to comply with anchoring material manufacturer's written instructions.
- B. Form or core-drill holes not less than 5 inches deep and 3/4 inch larger than OD of post for installing posts in concrete. Clean holes of loose material, insert posts, and fill annular space between post and concrete with nonshrink, nonmetallic grout, mixed and placed to comply with anchoring material manufacturer's written instructions.
- C. Cover anchorage joint with flange of same metal as post, welded to post after placing anchoring material.
- D. Leave anchorage joint exposed; wipe off surplus anchoring material; and leave 1/8-inch buildup, sloped away from post.
- E. Anchor posts to metal surfaces with oval flanges, angle type, or floor type as required by conditions, connected to posts and to metal supporting members as follows:
 - 1. For steel pipe railings, weld flanges to post and bolt to metal supporting surfaces.

3.05 ATTACHING RAILINGS

- A. Anchor railings as indicated on Drawings.
- B. Anchor railing ends at walls with round flanges anchored to wall construction and welded to railing ends or connected to railing ends using nonwelded connections.
- C. Anchor railing ends to metal surfaces with flanges bolted to metal surfaces and welded to railing ends or connected to railing ends using nonwelded connections.
- D. Attach railings to wall with wall brackets, except where end flanges are used. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads.
- E. Secure wall brackets and railing end flanges to building construction as follows:
 - 1. For concrete and solid masonry anchorage, use drilled-in expansion shields and hanger or lag bolts.
 - 2. For steel-framed partitions, use toggle bolts installed through flanges of steel framing or through concealed steel reinforcements.

3.06 ADJUSTING AND CLEANING

- A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material as used for shop painting to comply with SSPC-PA 1 requirements for touching up shop-painted surfaces.
 - 1. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.
- B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas, and repair galvanizing to comply with ASTM A 780/A 780M.

3.07 PROTECTION

- A. Protect finishes of railings from damage during construction period with temporary protective coverings approved by railing manufacturer. Remove protective coverings at time of Substantial Completion.

END OF SECTION 05 52 14

SECTION 05 53 13
STEEL BAR GRATINGS**PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section includes steel bar gratings and metal frames and supports for gratings.
- B. Locations: As shown on Drawings, including the following:
 - 1. Safety platform
 - 2. Wash bay

1.03 COORDINATION

- A. Coordinate installation of anchorages for gratings, grating frames, and supports. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

1.04 ACTION SUBMITTALS

- A. LEED Submittals:
 - 1. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.
- B. Shop Drawings: Include plans, sections, details, and attachments to other work.

1.05 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

1.06 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
 - 2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."

1.07 FIELD CONDITIONS

- A. Field Measurements: Verify actual locations of walls and other construction contiguous with gratings by field measurements before fabrication.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Alabama Metal Industries Corporation, a Gibraltar Industries company.
 2. Fisher & Ludlow.
 3. McNichols Co.
 4. Ohio Gratings, Inc.

2.02 METAL BAR GRATINGS

- A. Metal Bar Grating Standards: Comply with NAAMM MBG 531, "Metal Bar Grating Manual" and NAAMM MBG 532, "Heavy-Duty Metal Bar Grating Manual."
- B. Welded Steel Gratings:
1. Bearing Bar Spacing, Depth, Thickness, and Crossbar Spacing: Comply with Grating Marks indicated on Structural Drawings.
 2. Traffic Surface: Plain.
 3. Steel Finish: Hot-dip galvanized with a coating weight of not less than 1.8 oz./sq. ft. of coated surface.

2.03 FERROUS METALS

- A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
- B. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
- C. Steel Bars for Bar Gratings: ASTM A 36/A 36M or steel strip, ASTM A 1011/A 1011M or ASTM A 1018/A 1018M.
- D. Wire Rod for Bar Grating Crossbars: [ASTM A 510](#).
- E. Uncoated Steel Sheet: ASTM A 1011/A 1011M, structural steel, [Grade 30](#).

2.04 MISCELLANEOUS MATERIALS

- A. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20.
1. Use primer with a VOC content of 420 g/L (3.5 lb/gal.) or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.05 FABRICATION

- A. Shop Assembly: Fabricate grating sections in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.
1. Fabricate removable sections in weights not to exceed 50 pounds per section.
- B. Cut, drill, and punch material cleanly and accurately. Remove burrs and ease edges to a radius of approximately $1/32$ inch unless otherwise indicated. Remove sharp or

rough areas on exposed surfaces.

- C. Form from materials of size, thickness, and shapes indicated on Structural Drawings.
- D. Fit exposed connections accurately together to form hairline joints.
- E. Welding: Comply with AWS recommendations and the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
- F. Provide for anchorage of type indicated on Structural Drawings; coordinate with supporting structure. Fabricate and space the anchoring devices to secure frames rigidly in place.
- G. Removable Grating Sections: Fabricate with banding bars attached by welding to entire perimeter of each section.
- H. Fabricate cutouts in grating sections for penetrations indicated. Arrange cutouts to permit grating removal without disturbing items penetrating gratings.
 - 1. Edge-band openings in grating that interrupt four or more bearing bars with bars of same size and material as bearing bars.
- I. Do not notch bearing bars at supports to maintain elevation.

2.06 GRATING FRAMES AND SUPPORTS

- A. Fabricate from metal shapes, plates, and bars of welded construction to sizes, shapes, and profiles indicated and as necessary to receive gratings. Miter and weld connections for perimeter angle frames. Cut, drill, and tap units to receive hardware and similar items.
 - 1. Unless otherwise indicated, fabricate from same basic metal as gratings.
 - 2. Equip units indicated to be cast into concrete or built into masonry with integrally welded anchors of type and spacing indicated on Structural Drawings.
- B. Hot-dip galvanized steel frames and supports with a coating weight of not less than 1.8 oz./sq. ft. of coated surface.

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

- A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing gratings. Set units accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.
- B. Provide temporary bracing or anchors in formwork for frames and other items that are to be built into concrete or masonry.
- C. Fit exposed connections accurately together to form hairline joints.
 - 1. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade the

surfaces of exterior units that have been hot-dip galvanized after fabrication.

D. Field Welding: Comply with AWS recommendations and the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.

3.02 INSTALLING METAL BAR GRATINGS

A. General: Install gratings to comply with recommendations of referenced metal bar grating standards that apply to grating types and bar sizes indicated, including installation clearances and standard anchoring details.

3.03 ADJUSTING AND CLEANING

A. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780/A 780M.

1. Where used inside the building use primer complying with VOC limits specified in Part 2 "Products."

END OF SECTION 05 53 13

SECTION 05 58 00**SHEET METAL PANELS****PART I - GENERAL****1.1 SUMMARY****A. Definition:**

1. Work in this Section includes custom fabrication of sheet metal panels. Types of sheet metal include exterior station canopy panels and trim.

1.2 SUBMITTALS AND INFORMATION TO BE RETAINED

- A. Submittals shall be made in accordance with the requirements of the Project Quality Plan, except as modified herein.
- B. Product Data: Retain manufacturer's product data, installation instructions and general recommendations for each specified miscellaneous sheet metal product, including paint products and other finishing materials.
- C. Construction Drawings: Retain Construction Drawings for the fabrication of sheet metal work. Include plans, elevations and detail sections. Indicate jointing, fasteners, anchorage, and accessory items, and specify finishes.
- D. Samples: Retain 8" square samples of each metal finish. Prepare samples on metal of same alloy and gage to be used for the Work.

1.3 QUALITY ASSURANCE/QUALITY CONTROL

- A. Quality assurance/quality control shall be in accordance with the requirements of the Quality Plan and the General Provisions, except as modified herein.
- B. Shop Assembly: Preassemble items in the shop to the greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

1.4 REFERENCED STANDARDS

<u>Sponsor</u>	<u>Number</u>	<u>Subject</u>
ASTM	A653	Steel Sheet, Zinc-Coated or Zinc-Iron Alloy-Coated by the Hot Dip Process
ASTM	A591	Steel Sheet, Electrolytic Zinc-Coated, for Light Coating Weight (Moss) Applications
NAAMM	AMP 500-505	Metal Finishes Manual
SSPC	SP 1	Solvent Clearing (Steel Structures Painting Manual, Ch-2 Surface Preparation Specs.)
SSPC	SP 5	Joint Surface Preparation Standard White Metal Blast Cleaning NACE No.: 1994 (Steel Structures

		Painting Manual, Ch-2 Surface Preparation Specs.)
SSPC	SP 8	Picking (Steel Structures Painting Manual, Ch 2 – Surface Preparation Specs.)
SMACNA		Sheet Metal and AC Contractors National Association

PART II - PRODUCTS

2.1 MATERIALS

- A. General: Provide materials selected for their surface flatness, smoothness and freedom from surface blemishes where exposed to view in the finished unit. Do not use materials having exposed- to-view surfaces exhibiting pitting, seam marks, roller marks "oil canning", stains, discoloration or other imperfections.
- B. Galvanized Sheet Steel: ASTM A 653 (commercial quality or lockforming quality), Coating Designation G90, mill phosphatized.
- C. Sheet Steel: Provide commercial quality cold-rolled carbon steel sheet as follows, unless otherwise indicated.
- D. Zinc-Coated Sheet Steel: ASTM A 591, with Class C zinc coating chemically treated in mill with phosphate solution and light chromate rinse.
- E. Fasteners: Use fasteners made of the same basic metal as the fastened metal, unless otherwise indicated. Do not use metals that are corrosive or incompatible with materials joined.
 - 1. Do not use exposed fasteners except where unavoidable. Match finish of metal surrounding fastener, unless otherwise indicated.
- F. Shop-Applied Enamel Finish System for Sheet Steel: Two coats Exterior Alkyd Urethane Semi-gloss enamel, DeVoe "Mirrolac" or equal, applied over DeVoe Primer 13201, or equal.
 - 1. Color to be selected by Architect.
- G. Joint Sealers: See Section 07 92 13.

2.2 FABRICATION, GENERAL

- A. Fabricate items to comply with requirements indicated, on Design Drawings including those for quality, thickness and finish of material as well as those indicating dimensions and details. Use heavier metal gages, stiffeners or metal backing as required to produce surface flatness, free of "oil-canning", and to impart sufficient strength for use indicated. If not otherwise indicated, provide the following minimum thickness of metal and comply with SMACNA recommendations for fabrication and installation details.
 - 1. Sheet Steel: Gauge as indicated on Design Drawings.
- B. Form sheet metals items in maximum lengths and keep joints to a minimum. Do not expose cut edges of sheet metal except as indicated. Fold back exposed ends of unsupported sheet metal to form a 2" wide hem on the concealed side, or ease exposed edges with backing to a

radius of approximately $\frac{1}{32}$ ". Form items with flat, flush surfaces, true to line and level, and without cracking and grain separation at bends.

- C. Continuously weld all joints and seams except where other methods of joining are indicated on Design Drawings; grind welds smooth and flush on exposed surfaces. Comply with AWS and other metal authorities.
- D. Provide straps, plates and brackets as required for support and anchorage of fabricated items to adjoining Work.
- E. Reinforce sheet metal items as required for attachment and support of hinges, catches and other hardware for operating components.

2.3 PANELS AND TRIM

- A. Form panel and trim members to the profiles shown on Design Drawings. Furnish all components required for support and installation of closures and trim. Fabricate closures and trim to tightly close with adjoining Work, and with weathertight joints at exterior installations.
- B. Locate fasteners to be concealed where possible; otherwise to be as inconspicuous as possible. Size to securely support the Work and space to prevent buckling or waviness of the finished surface.
- C. Drill and tap holes required for securing closures to other surfaces.
- D. Provide gaskets of closed-cell sponge neoprene or mastic sealing tape where shown on Design Drawings or required for concealed, continuous seal at abutting surfaces.
- E. Provide concealed support at joints to hold meeting faces in flush alignment. Miter or cope trim members at corners to form tight joints.

2.4 POCKETS FOR GLAZING TREATMENT

- A. Form pockets to profiles shown on Design Drawings using 18 gage sheet steel, unless otherwise indicated. Provide end closures and coordinate dimensions and attachment methods with window treatment equipment, window frames, ceiling suspension system, and other related Work to produce a coordinated and integrated assembly. Reinforce pocket for attachment of window treatment equipment and hardware or use heavier gage metal.
- B. For continuous pockets provide built-in filler panels between adjoining window treatment units to coincide with window mullions and of size indicated or required to fit to filler panels at ends of partitions.

2.5 SHOP FINISHING

- A. General:
 - 1. Comply with NAAMM AMP 500-505 for finish designations and application recommendations, except as otherwise indicated on Design Drawings.
 - 2. Complete mechanical finishes of flat sheet metal surfaces before fabrication, wherever possible. After fabrication, finish all joints, bends, abrasions, and other surface blemishes to match the sheet finish. Protect mechanical finishes on exposed surfaces from damage by application of adhesive paper or other temporary protective covering, prior to shipment.

- B. Colors: Provide colors indicated on Design Drawings, or if not indicated, as selected by Owner.
- C. Sheet Steel: Surface Preparation: Solvent-clean surfaces in compliance with SSPC-SP 1 to remove dirt, oil, grease and other contaminants that could impair paint bond. Remove mill scale and rust, if present, from uncoated steel in compliance with SSPC-SP 5 (White Metal Blast Cleaning) or SSPC-SP 8 (Pickling).
- D. Factory-Primed Sheet Steel: Apply shop primer for sheet steel immediately following surface preparation and pretreatment.
- E. Enamel Finish: Apply coats in strict compliance with paint manufacturer's specifications.

PART III - EXECUTION

3.1 PREPARATION

- A. Field Measurements: Perform sheet metal Work in cooperation with other trades. Where possible, verify size, location and placement of miscellaneous sheet metal work prior to fabrication. Coordinate field measurements and Construction Drawings with fabrication and shop assembly.
- B. Coordinate setting drawings, diagrams, templates, instructions, and directions for the installation of anchorages, such as concrete inserts, anchor bolts and miscellaneous items having integral anchors, which are to be embedded in concrete or masonry construction. Coordinate the delivery of such items to the Project site.

3.2 INSTALLATION

- A. Locate and place sheet metal items plumb, level and in alignment with adjacent Work.
- B. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect sheet metal surfaces and to make a weathertight connection.
- C. Form tight joints with exposed connections accurately fitted together. Provide reveals and openings for sealants and joint fillers, as shown on Design Drawings.
- D. Protect zinc-coated, galvanized and non-ferrous metal surfaces from corrosion or galvanic action by application of a heavy coating of bituminous paint on surfaces which will be in contact with concrete, masonry or dissimilar metals.
- E. Repair finishes damaged by cutting, welding, soldering and grinding operations required for shop fitting and jointing. Restore finishes and prime coats of paint so that there is no evidence of corrective Work. Return items which cannot be refinished in the field to the shop, make required alterations, and refinish the entire unit or provide new units, at fabricator's option.
- F. Provide concealed gaskets, flashing, sealants, fillers and insulation, and install as the Work progresses to make the installation weathertight or sealed.

PART IV - MEASUREMENT

- 4.1 Measurement** – No Separate measurement will be made for Work described in this Section.

PART V - PAYMENT

5.1 Payment – Payment for items in this Section will be incidental to the Contract unit cost of the metal bid items.

END OF SECTION

SECTION 05 73 13
GLASS-SUPPORTED RAILINGS**PART 1 - GENERAL****1.1 SUMMARY**

- A. Furnish labor, materials, tools, equipment, and services for Glass Supported Railings, as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

- A. References standards:
 - 1. Architectural Aluminum Manufacturer's Association (AAMA) for aluminum.
 - 2. American Society for Testing and Materials (ASTM).
 - 3. National Association of Architectural Metals Manufacturers (NAAMM) for metal finishes.
 - 4. American National Standards Institute (ANSI).
 - 5. American Iron and Steel Institute (AISI) for stainless steel.
 - 6. Copper Development Association (CDA) for bronze.
 - 7. ANSI Z97.1 - Safety Glazing Material Used in Buildings.
- B. Material Standards:
 - 1. General:
 - a. Refer to Part 2 for component materials required.
 - b. Refer to Part 2 for finishes required.
 - 2. Structural steel components: ASTM-A36, ASTM-A501, ASTM-A575 or ASTM-A108.
 - 3. Aluminum components: Alloy 6063-T52 for extruded pipe sections and posts in accord with ASTM-B221.
 - a. Anodic Finish Standards (where applicable):
 - 1) Clear Anodized: AA-M12-C22-A41 in accord with AAMA 606.1.
 - 4. Stainless Steel:
 - a. AISI Type 304.
 - b. Finish(es) indicated to comply with ASTM-A480.
- C. Design Responsibility - General:
 - 1. Engineering design submittal must be performed by, or under the direct supervision of, a registered Engineer, licensed to practice Structural Engineering in State of Missouri.
 - 2. Submittal must include calculations for all Rails, Posts, Balusters, Pickets, Infill members, and other load-resisting components.
 - a. Note design live loads on submittal.
 - 3. Submittal to be reviewed by A/E for general conformance with design intent shown by Contract Documents
 - a. Physical adequacy of Structural design, and conformance with applicable building Codes are the responsibility of the railing fabricator.
 - 4. Component sizes shall comply as indicated except larger/stronger members may be used where additional strength is required.
 - a. Demonstrate by calculations performed by qualified Engineer employed by the fabricator.
- D. Code Compliance:
 - 1. Design Glass-supported Railing system to comply with:
 - a. International Building Code as locally adopted.
 - b. ADA requirements.

- E. Top of guardrail systems capable of withstanding the following loads applied as indicated:
 - 1. Concentrated load of 250 LB applied at any point and in any direction.
 - 2. Uniform load of 50 LB per linear FT applied horizontally and concurrently with uniform load of 100 LB/Lineal FT applied vertically downward.
 - 3. Concentrated load need not be assumed to act concurrently with uniform loads.
- F. Handrails not serving as top rails capable of withstanding the following loads applied as indicated:
 - 1. Concentrated load of 250 LB applied at any point and in any direction.
 - 2. Uniform dead load of 50 LB/Lineal FT applied in any direction.
 - 3. Concentrated load need not be assumed to act concurrently with uniform loads.
- G. Infill area of guardrail systems capable of withstanding a horizontal concentrated load of 250 LB applied to 1 FT² at any point in the system.
 - 1. Above load need not be assumed to act concurrently with loads on top rails of railing system in determining stress on guard.
- H. Mock-Ups
 - 1. Provide full scale mock-up of the guardrails to accurately represent the materials, attachments, and assembly indicated in the Drawings. Approved mock-up may be incorporated into the Work.

1.3 SUBMITTALS

- A. Shop Drawings:
 - 1. Including elevations, sections, and details, indicating materials, components, sizes, dimensions, tolerances, hardware, fasteners, finishes, options, accessories, and installation.
 - 2. Indicate component details, materials, finishes, connection and joining methods.
 - 3. Show details of attaching railing system to supports.
- B. Product Data:
 - 1. Manufacturer's product data, including description of materials, components, fabrication, installation details and finishes.
- C. Samples:
 - 1. Submit manufacturer's samples of standard materials, finishes, colors, and textures.
 - 2. Minimum 2 IN x 4 IN sample of specified finish.
- D. Project Information:
 - 1. Engineering calculations indicating design moments, shears, and other forces sealed by registered Engineer, licensed to practice Structural Engineering in the State of Missouri.
 - a. Submit concurrent with Shop Drawings.
 - 2. Test reports.
- E. Contract Closeout Information:
 - 1. Maintenance Instructions.
 - 2. Warranty.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Glass-Supported Railing System:
 - 1. Base:
 - a. Livers Bronze, Co.
 - 2. Optional:

- a. Julius Blum & Co.
 - b. J.G. Braun.
 - c. Blumcraft of Pittsburgh.
- B. Dissimilar metal protection coating:
1. Base:
 - a. Tnemec.
- C. Grout, non-shrink:
1. Base:
 - a. Dayton Superior Corporation.
 2. Optional:
 - a. Sauereisen Cements Co.
 - b. Minwax.
- D. Other manufacturers desiring approval comply with Section 00 25 00.

2.2 GLASS-SUPPORTED RAILING SYSTEM

- A. General:
1. Frameless glass panel guardrail anchored to concrete
- B. Glass:
1. Kind: Tempered plate glass complying with ANSI Z97.1.
 - a. Utilized bent tempered units where curved rails are indicated.
 2. Thickness:
 - a. 1/2 IN.
 3. Color:
 - a. Clear.
 4. Field glaze glass panels.
- C. Anchors
1. Stainless steel concrete anchor embedded and sized to meet load requirements.
 2. Aluminum cap
 3. Rubber washers
- D. Glass Cap:
1. Metal U-shaped channel applied to top edge of glass railing where indicated on the Drawings.
 2. Include all gaskets, fasteners and other items required.

2.3 FINISHES

- A. Aluminum Items:
1. Clear Anodized
- B. Miscellaneous Items:
1. Anchorage devices:
 - a. Furnish anchorage devices compatible with system and substrate.
 2. Grout, non-shrink:
 - a. Compressive strength: 9000 PSI at 7 days.
 - b. Base Product: 1107 Advantage Grout by Dayton Superior Corporation,

2.4 FABRICATION

- A. Form to shapes and profiles indicated with straight lines, sharp angles, smooth curves.
- B. Drill or punch holes with smooth edges for temporary field connections and attachment of work by other trades.
- C. Conceal fastenings where practicable.
- D. Shop fabricate in as large assemblies as practicable.

- E. Provide dissimilar metal protection coating:
 - 1. When dissimilar metals come in contact.
 - 2. When metal or aluminum is anchored to or in contact with concrete or masonry.
- F. Cut material square and remove burrs from exposed edges with no chamfer.
- G. Make rails smooth with no projections preventing a hand from sliding along entire length.
- H. Make exposed joints with ¼" spacing and flush.
- I. Close exposed ends of pipes or rails with end caps.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive railing system.
 - 1. Verify suitability of substrate to accept installation.
- B. Correct non-conforming conditions.
- C. Do not begin installation until unacceptable conditions have been corrected.
 - 1. Installation constitutes acceptance of responsibility for performance.

3.2 INSTALLATION

- A. General:
 - 1. Install railing system in accordance with manufacturer's instructions and approved Shop Drawings.
 - 2. Install railing system plumb, level, square, true to line, and rigid.
 - 3. Attach railing system securely in place using fasteners supplied or approved by manufacturer.
 - a. Where practical, conceal fastenings.
 - b. Attach railing system to supports supplied or approved by manufacturer.
 - c. Use manufacturer's supplied hardware.
 - 4. Field-weld components as approved by manufacturer.
- B. Shim and grout as necessary.
- C. Secure metal to concrete with embedded anchors, setting compounds, caulking and sleeves, or setting grout.
- D. Meet structural requirements for erecting items of structural nature.
- E. Do not field splice fabricated items unless size requires splicing.
- F. Provide fabricated items complete with attachment devices as required to install.

3.3 ERECTION TOLERANCES

- A. Set glass plumb within a tolerance of 1:200 1/16 IN in 12 IN.
- B. Fit exposed connections accurately together to form tight hairline joints except as required for expansion.

3.4 PROTECTION

- A. Protect installed railing system and finish from damage during other construction.
- B. Repair minor damages to finish in accordance with manufacturer's instructions and as approved by Architect.

- C. Remove and replace defective or damaged components that cannot be successfully repaired as determined by Architect.

3.5 CLEANING

- A. Clean railing system promptly after installation in accordance with manufacturer's instructions.
- B. Do not use harsh cleaning materials or methods that would damage glass or finish.
- C. Do not use abrasive cleaners.

PART 4 - MEASUREMENT

4.1 Measurement – No Separate measurement will be made for Work described in this Section.

PART 5 - PAYMENT

5.1 Payment – Payment for items in this Section will be incidental to the Contract lump sum cost of the Station Stops.

END OF SECTION

SECTION 06 10 53**MISCELLANEOUS ROUGH CARPENTRY****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. This Section includes the following:
 - 1. Wood blocking and nailers.
 - 2. Plywood backing panels.
- B. Related Sections include the following:
 - 1. Division 06 Section "Interior Architectural Woodwork" for nonstructural carpentry items exposed to view and not specified in another Section.

1.03 DEFINITIONS

- A. Lumber grading agencies, and the abbreviations used to reference them, include the following:
 - 1. NELMA - Northeastern Lumber Manufacturers Association.
 - 2. NLGA - National Lumber Grades Authority.
 - 3. SPIB - Southern Pine Inspection Bureau.
 - 4. WCLIB - West Coast Lumber Inspection Bureau.
 - 5. WWPA - Western Wood Products Association.

1.04 SUBMITTALS

- A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.
 - 1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used, net amount of preservative retained, and chemical treatment manufacturer's written instructions for handling, storing, installing, and finishing treated material.
 - 2. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Include physical properties of treated materials, both before and after exposure to elevated temperatures when tested according to ASTM D 5516 and ASTM D 5664.

3. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.
 4. Include copies of warranties from chemical treatment manufacturers for each type of treatment.
- B. Fastener and Anchorage Schedule.
- C. LEED Submittals:
1. Product Data for Credit EQ 4.1: For adhesives, including printed statement of VOC content.
 2. Product Data for Credit EQ 4.4: For composite-wood products, documentation indicating that product contains no urea formaldehyde.
 3. Certificates for Credit MR 7: Chain-of-custody certificates certifying that products specified to be made from certified wood comply with forest certification requirements. Include evidence that mill is certified for chain of custody by an FSC-accredited certification body.
 - a. Include statement indicating costs for each certified wood product.
- D. Evaluation Reports: For the following, from ICC-ES:
1. Fire-retardant-treated wood.
 2. Power-driven fasteners.
 3. Powder-actuated fasteners.
 4. Expansion anchors.
 5. Metal framing anchors.

1.05 QUALITY ASSURANCE

- A. Forest Certification: For the following wood products, provide materials produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship":
4. Miscellaneous lumber.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Stack lumber, plywood, and other panels; place spacers between each bundle to provide air circulation. Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS

2.01 WOOD PRODUCTS, GENERAL

- A. Certified Wood: Lumber and plywood shall be produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."
- A. Lumber: DOC PS 20 and applicable rules of lumber grading agencies certified by the American Lumber Standards Committee Board of Review.

1. Factory mark each piece of lumber with grade stamp of grading agency.
2. Where nominal sizes are indicated, provide actual sizes required by DOC PS 20 for moisture content specified. Where actual sizes are indicated, they are minimum dressed sizes for dry lumber.
3. Provide dressed lumber, S4S, unless otherwise indicated.
4. Provide dry lumber with 19 percent maximum moisture content at time of dressing for 2-inch nominal thickness or less, unless otherwise indicated.
5. Provide dry lumber with 15 percent maximum moisture content at time of dressing for 2-inch nominal thickness or less, unless otherwise indicated.

2.02 FIRE-RETARDANT-TREATED MATERIALS

- A. General: Comply with performance requirements in AWPA C20 (lumber) and AWPA C27 (plywood).
 1. Use treatment that does not promote corrosion of metal fasteners.
 2. Use Interior Type A, unless otherwise indicated.
- B. Identify fire-retardant-treated wood with appropriate classification marking of testing and inspecting agency acceptable to authorities having jurisdiction.
- C. Application: Treat all concealed blocking to be installed in interior walls and partitions:

2.03 MISCELLANEOUS LUMBER

- A. General: Provide lumber for support or attachment of other construction, including the following:
 1. Blocking
 2. Nailers.
 3. Grounds.
- B. For items of dimension lumber size, provide Construction, Stud, or No. 2 grade lumber with 19 percent maximum moisture content and any of the following species:
 1. Mixed southern pine; SPIB.
 2. Eastern softwoods; NELMA.
 3. Northern species; NLGA.
 4. Western woods; WCLIB or WWPA.
- C. For concealed boards, provide lumber with 19 percent maximum moisture content and any of the following species and grades:
 1. Mixed southern pine, No. 2 grade; SPIB.
 2. Eastern softwoods, No. 2 Common grade; NELMA.
 3. Northern species, No. 2 Common grade; NLGA.
 4. Western woods, Construction or No. 2 Common grade; WCLIB or WWPA.

2.04 PANEL PRODUCTS

- A. Miscellaneous Concealed Plywood: Exposure 1 sheathing, span rating to suit framing in each location, and thickness as indicated but not less than 1/2 inch.
- B. Telephone and Electrical Equipment Backing Panels: DOC PS 1, Exposure 1, C-D Plugged, fire-retardant treated, in thickness indicated or, if not indicated, not less than

1/2 inch thick.

2.05 FASTENERS

- A. General: Provide fasteners of size and type indicated that comply with requirements specified in this Article for material and manufacture.
- B. Nails, Wire, Brads, and Staples: FS FF-N-105.
- C. Power-Driven Fasteners: CABO NER-272.
- D. Wood Screws: ASME B18.6.1.
- E. Screws for Fastening to Cold-Formed Metal Framing: ASTM C 954, except with wafer heads and reamer wings, length as recommended by screw manufacturer for material being fastened.
- F. Lag Bolts: ASME B18.2.1
- G. Bolts: Steel bolts complying with ASTM A 307, Grade A; with ASTM A 563 hex nuts and, where indicated, flat washers.
- H. Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to 6 times the load imposed when installed in unit masonry assemblies and equal to 4 times the load imposed when installed in concrete as determined by testing per ASTM E 488 conducted by a qualified independent testing and inspecting agency.
 - 1. Material: Carbon-steel components, zinc plated to comply with ASTM B 633, Class Fe/Zn 5.
 - 2. Material: Stainless steel with bolts and nuts complying with ASTM F 593 and ASTM F 594, Alloy Group 1 or 2.

2.06 METAL FRAMING ANCHORS

- A. General: Provide galvanized steel framing anchors of structural capacity, type, and size indicated and acceptable to authorities having jurisdiction.
- B. Galvanized Steel Sheet: Hot-dip, zinc-coated steel sheet complying with ASTM A 653/A 653M, G60 coating designation.

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

- A. Discard units of material with defects that impair quality of carpentry and that are too small to use with minimum number of joints or optimum joint arrangement.
- B. Set carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit carpentry to other construction; scribe and cope as needed for accurate fit. Locate furring, nailers, blocking, grounds, and similar supports to comply with requirements for attaching other construction.

- C. Apply field treatment complying with AWPA M4 to cut surfaces of preservative-treated lumber and plywood.
- D. Securely attach carpentry work as indicated and according to applicable codes and recognized standards.
- E. Countersink fastener heads on exposed carpentry work and fill holes with wood filler.
- F. Use fasteners of appropriate type and length. Pre-drill members when necessary to avoid splitting wood.

3.02 WOOD GROUND, BLOCKING, AND NAILER INSTALLATION

- A. Install where indicated and where required for screeding or attaching other work. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved.
- B. Attach items to substrates to support applied loading. Recess bolts and nuts flush with surfaces, unless otherwise indicated.

3.03 WOOD FURRING INSTALLATION

- A. Install level and plumb with closure strips at edges and openings. Shim with wood as required for tolerance of finish work.
- B. Furring to Receive Gypsum Board: Install 1-by-2-inch nominal- size furring vertically at 16 inches o.c.

3.04 PROTECTION

- A. Protect wood that has been treated with inorganic boron (SBX) from weather. If, despite protection, inorganic boron-treated wood becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.
- B. Protect rough carpentry from weather. If, despite protection, rough carpentry becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

END OF SECTION 06 10 53

SECTION 06 16 43
GYP SUM SHEATHING**PART 1 - GENERAL****1.01 SUMMARY**

- A. This Section includes the following:
 - 1. Wall sheathing.
- B. Related Sections include the following:
 - 1. Division 07 Section "Weather Barriers" for air barrier and flexible flashings.

1.02 SUBMITTALS

- A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.
- B. LEED Submittals:
 - 1. Product Data for Credit EQ 4.1: For adhesives, including printed statement of VOC content.

1.03 QUALITY ASSURANCE

- A. Fire-Test-Response Characteristics: For assemblies with fire-resistance ratings, provide materials and construction identical to those of assemblies tested for fire resistance per ASTM E 119 by a testing and inspecting agency acceptable to authorities having jurisdiction.
 - 1. Fire-Resistance Ratings: Indicated by design designations from UL's "Fire Resistance Directory."

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Stack panels flat with spacers between each bundle to provide air circulation. Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS**2.01 WALL SHEATHING**

- A. Glass-Mat Gypsum Wall Sheathing: ASTM C 1177/1177M.
 - 1. Available Products: Subject to compliance with requirements, provide one of the following products:
 - a. "Dens-Glass Gold" by G-P Gypsum Corporation.
 - b. "Securock" by USG Corporation
 - 2. Type and Thickness: Type X, 5/8 inch thick.
 - 3. Size: 48 by 96 inches.

2.02 FASTENERS

- A. General: Provide fasteners of size and type indicated that comply with requirements specified in this Article for material and manufacture.
 - 1. For wall sheathing, provide fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M.
- B. Screws for Fastening Gypsum Sheathing to Cold-Formed Metal Framing: Steel drill screws, in length recommended by sheathing manufacturer for thickness of sheathing board to be attached, with organic-polymer or other corrosion-protective coating having a salt-spray resistance of more than 800 hours according to ASTM B 117.
 - 1. For steel framing less than 0.0329 inch thick, attach sheathing to comply with ASTM C 1002.
 - 2. For steel framing from 0.033 to 0.112 inch thick, attach sheathing to comply with ASTM C 954.

2.03 SHEATHING JOINT-AND-PENETRATION TREATMENT MATERIALS

- A. Sealant for Sheathing Board: Elastomeric, medium-modulus, neutral-curing silicone joint sealant compatible with joint substrates formed by gypsum sheathing and other materials, recommended by sheathing manufacturer for application indicated, and complying with requirements for elastomeric sealants specified in Division 07 Section "Joint Sealants."
 - 1. VOC Content of Interior Sealants: Provide sealants and sealant primers for use inside the weatherproofing system that comply with the following limits for VOC content when calculated according to 40 CFR 59, Part 59, Subpart D (EPA Method 24):
 - a. Architectural Sealants: 250 g/L.
 - b. Sealant Primers for Porous Substrates: 775 g/L.

2.04 MISCELLANEOUS MATERIALS

- A. Adhesives for Field Gluing Panels to Framing: Formulation complying with APA AFG-01 that is approved for use with type of construction panel indicated by manufacturers of both adhesives and panels.
 - 1. Adhesives shall have a VOC content of 70g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

- A. Do not use materials with defects that impair quality of sheathing or pieces that are too small to use with minimum number of joints or optimum joint arrangement.
- B. Cut panels at penetrations, edges, and other obstructions of work; fit tightly against abutting construction, unless otherwise indicated.
- C. Securely attach to substrate by fastening as indicated, complying with the following:
 - 1. NES NER-272 for power-driven fasteners.
 - 2. Table 2304.9.1, "Fastening Schedule," in ICC's "International Building Code."

- D. Coordinate wall sheathing installation with flashing and joint-sealant installation so these materials are installed in sequence and manner that prevent exterior moisture from passing through completed assembly.
- E. Do not bridge building expansion joints; cut and space edges of panels to match spacing of structural support elements.
- F. Coordinate sheathing installation with installation of materials installed over sheathing so sheathing is not exposed to precipitation or left exposed at end of the workday when rain is forecast.

3.02 GYPSUM SHEATHING INSTALLATION

- A. Comply with GA-253 and with manufacturer's written instructions.
 - 1. Fasten gypsum sheathing to cold-formed metal framing with screws.
 - 2. Install boards with a 3/8-inch gap where non-load-bearing construction abuts structural elements.
 - 3. Install boards with a 1/4-inch gap where they abut masonry or similar materials that might retain moisture, to prevent wicking.
- B. Apply fasteners so heads bear tightly against face of sheathing boards but do not cut into facing.
- C. Vertical Installation: Install board vertical edges centered over studs. Abut ends and edges of each board with those of adjacent boards. Attach boards at perimeter and within field of board to each stud.
 - 1. Space fasteners approximately 8 inches o.c. and set back a minimum of 3/8 inch from edges and ends of boards.

3.03 SHEATHING JOINT-AND-PENETRATION TREATMENT

- A. Seal sheathing joints according to sheathing manufacturer's written instructions.
 - 1. Apply elastomeric sealant to joints and fasteners and trowel flat. Apply sufficient quantity of sealant to completely cover joints and fasteners after troweling. Seal other penetrations and openings.

3.04 PROTECTION

- A. Apply covering to sheathing within time period recommended by sheathing manufacturer.

3.05 CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

- A. Comply with Waste Management Plan required under Division 01 Section "Construction Waste Management And Disposal."

END OF SECTION 06 16 43

SECTION 06 40 23**INTERIOR ARCHITECTURAL WOODWORK****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. This Section includes the following:
 - 1. Plastic-laminate cabinets.
 - 2. Solid-surfacing-material countertops.
- B. Related Sections include the following:
 - 1. Division 06 Section "Miscellaneous Rough Carpentry" for wood furring, blocking, shims, and hanging strips required for installing woodwork and concealed within other construction before woodwork installation.

1.03 DEFINITIONS

- A. Interior architectural woodwork includes wood furring, blocking, shims, and hanging strips for installing woodwork items unless concealed within other construction before woodwork installation.

1.04 SUBMITTALS

- A. Product Data: For each type of product indicated, including cabinet hardware and accessories and finishing materials and processes.
- B. Shop Drawings: Show location of each item, dimensioned plans and elevations, large-scale details, attachment devices, and other components.
 - 1. Show details full size.
 - 2. Show locations and sizes of furring, blocking, and hanging strips, including concealed blocking and reinforcement specified in other Sections.
 - 3. Show locations and sizes of cutouts and holes for plumbing fixtures and other items installed in architectural woodwork.
 - 4. Apply AWI-certified compliance label to first page of Shop Drawings.
 - 5. Include Fastener and Anchorage Schedule for attaching interior architectural woodwork to blocking.
- C. Samples for Verification:
 - 1. Plastic laminates, 8 by 10 inches, for each type, color, pattern, and surface finish, with 1 sample applied to core material and specified edge material applied to 1 edge.
 - 2. Thermoset decorative-panels, 8 by 10 inches, for each type, color, pattern, and surface finish, with edge banding on 1 edge.
 - 3. Solid-surfacing materials, 6 inches square.
 - 4. Corner pieces as follows:

- a. Cabinet-front frame joints between stiles and rails, as well as exposed end pieces, 18 inches high by 18 inches wide by 6 inches deep.
 - b. Miter joints for standing trim.
5. Exposed cabinet hardware and accessories, one unit for each type and finish.
- D. LEED Submittals:
1. Product Data for Credit EQ 4.1: For installation adhesives, including printed statement of VOC content.
 2. Product Data for Credit EQ 4.4:
 - a. For each composite-wood product used, documentation indicating that the bonding agent contains no urea formaldehyde.
 - b. For each adhesive used, documentation indicating that the adhesive contains no urea formaldehyde.
 3. Product Data for Credit(s) MR 4.1 and MR 4.2: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content
 - a. Include statement indicating costs for each product having recycled content.
 4. Product Data for Credit MR 5.1: For products regionally extracted and manufactured material, including source and cost.
- E. Product Certificates: For each type of product, signed by product manufacturer.
- F. Woodwork Quality Standard Compliance Certificates: AWI-certified compliance certificates.
- G. Qualification Data: For fabricator.

1.05 QUALITY ASSURANCE

- A. Fabricator Qualifications: Shop that employs skilled workers who custom-fabricate products similar to those required for this Project and whose products have a record of successful in-service performance. Shop is a licensee of AWI's Certified Compliance Program.
- B. Quality Standard: Unless otherwise indicated, comply with AWI's "Manual of Millwork" for grades of interior architectural woodwork indicated for construction, finishes, installation, and other requirements.
 1. Provide AWI-certified compliance labels and certificates indicating that woodwork, including installation, complies with requirements of grades specified.
- C. Fire-Test-Response Characteristics: Where fire-retardant materials or products are indicated, provide materials and products with specified fire-test-response characteristics as determined by testing identical products per test method indicated by UL, ITS, or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify with appropriate markings of applicable testing and inspecting agency in the form of separable paper label or, where required by authorities having jurisdiction, imprint on surfaces of materials that will be concealed from view after installation.
- D. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Do not deliver woodwork until painting and similar operations that could damage woodwork have been completed in installation areas. If woodwork must be stored in other than installation areas, store only in areas where environmental conditions comply with requirements specified in "Project Conditions" Article.

1.07 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install woodwork until building is enclosed, wet work is complete, and HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.
- B. Field Measurements: Where woodwork is indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication, and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
 1. Locate concealed framing, blocking, and reinforcements that support woodwork by field measurements before being enclosed, and indicate measurements on Shop Drawings.
 2. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating woodwork without field measurements. Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.

1.08 COORDINATION

- A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to ensure that interior architectural woodwork can be supported and installed as indicated.
- B. Hardware Coordination: Distribute copies of approved hardware schedule specified in Division 08 Section "Door Hardware (Scheduled by Describing Products)" to fabricator of architectural woodwork; coordinate Shop Drawings and fabrication with hardware requirements.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. General: Provide materials that comply with requirements of AWI's quality standard for each type of woodwork and quality grade specified, unless otherwise indicated.
- B. Wood Products: Comply with the following:
 1. Recycled Content of Medium-Density Fiberboard and Particleboard: Provide products with an average recycled content so postconsumer recycled content plus one-half of preconsumer recycled content is not less than 20 percent.
 2. Hardboard: AHA A135.4.
 3. Medium-Density Fiberboard: ANSI A208.2, Grade MD, made with binder

- containing no urea formaldehyde.
 - 4. Particleboard: ANSI A208.1, Grade M-2-Exterior Glue.
 - 5. Softwood Plywood: DOC PS 1, Medium Density Overlay.
- C. Thermoset Decorative Panels: Particleboard or medium-density fiberboard finished with thermally fused, melamine-impregnated decorative paper complying with LMA SAT-1.
- 1. Provide PVC or matching plastic laminate edge banding complying with LMA EDG-1 on components with exposed or semiexposed edges.
- D. High-Pressure Decorative Laminate: NEMA LD 3, grades as indicated or, if not indicated, as required by woodwork quality standard.
- 1. Basis of Design: Subject to compliance with requirements, provide products indicated on Finish Legend on Drawings.
- E. Solid-Surfacing Material: Homogeneous solid sheets of filled plastic resin complying with ISSFA-2.
- 1. Basis of Design: Subject to compliance with requirements, provide products indicated on Finish Legend on Drawings.

2.02 FIRE-RETARDANT-TREATED MATERIALS

- A. General: Where fire-retardant-treated materials are indicated, use materials complying with requirements in this Article, that are acceptable to authorities having jurisdiction, and with fire-test-response characteristics specified.
- 1. Do not use treated materials that do not comply with requirements of referenced woodworking standard or that are warped, discolored, or otherwise defective.
 - 2. Use fire-retardant-treatment formulations that do not bleed through or otherwise adversely affect finishes. Do not use colorants to distinguish treated materials from untreated materials.
 - 3. Identify fire-retardant-treated materials with appropriate classification marking of UL, U.S. Testing, Timber Products Inspection, or another testing and inspecting agency acceptable to authorities having jurisdiction.
- B. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Comply with performance requirements of AWWA C20 (lumber) and AWWA C27 (plywood). Use the following treatment type:
- 1. Exterior Type: Organic-resin-based formulation thermally set in wood by kiln drying.
 - 2. Interior Type A: Low-hygroscopic formulation.
 - 3. Mill lumber after treatment within limits set for wood removal that do not affect listed fire-test-response characteristics, using a woodworking plant certified by testing and inspecting agency.
 - 4. Mill lumber before treatment and implement special procedures during treatment and drying processes that prevent lumber from warping and developing discolorations from drying sticks or other causes, marring, and other defects affecting appearance of treated woodwork.
 - 5. Kiln-dry materials before and after treatment to levels required for untreated materials.
- C. Fire-Retardant Particleboard: Panels complying with the following requirements, made from softwood particles and fire-retardant chemicals mixed together at time of panel manufacture to achieve flame-spread index of 25 or less and smoke-developed

index of 25 or less per ASTM E 84.

1. For panels 3/4 inch thick and less, comply with ANSI A208.1 for Grade M-2 except for the following minimum properties: modulus of rupture, 1600 psi; modulus of elasticity, 300,000 psi; internal bond, 80 psi; and screw-holding capacity on face and edge, 250 and 225 lbf, respectively.
2. For panels 13/16 to 1-1/4 inches thick, comply with ANSI A208.1 for Grade M-1 except for the following minimum properties: modulus of rupture, 1300 psi; modulus of elasticity, 250,000 psi; linear expansion, 0.50 percent; and screw-holding capacity on face and edge, 250 and 175 lbf, respectively.
3. Product: Subject to compliance with requirements, provide "Duraflake FR" by Weyerhaeuser.

D. Fire-Retardant Fiberboard: Medium-density fiberboard panels complying with ANSI A208.2, made from softwood fibers, synthetic resins, and fire-retardant chemicals mixed together at time of panel manufacture to achieve flame-spread index of 25 or less and smoke-developed index of 200 or less per ASTM E 84.

1. Product: Subject to compliance with requirements, provide "Meditate FR" by SierraPine Ltd.; Medite Div.

2.03 CABINET HARDWARE AND ACCESSORIES

A. General: Provide cabinet hardware and accessory materials associated with architectural cabinets, except for items specified in Division 08 Section "Door Hardware."

B. Butt Hinges: 2-3/4-inch, 5-knuckle steel hinges made from 0.095-inch- thick metal, and as follows:

1. Semiconcealed Hinges for Flush Doors: BHMA A156.9, B01361.
2. Semiconcealed Hinges for Overlay Doors: BHMA A156.9, B01521.

C. Back-Mounted Pulls: BHMA A156.9, B02011.

D. Wire Pulls: Back mounted, solid metal 5 inches long, 2-1/2 inches deep, and 5/16 inch in diameter.

E. Catches: Magnetic catches, BHMA A156.9, B03141.

F. Adjustable Shelf Standards and Supports: BHMA A156.9, B04071; with shelf rests, B04081.

G. Shelf Rests: BHMA A156.9, B04013; metal, two-pin type with shelf hold-down clip.

H. Drawer Slides: BHMA A156.9, B05091.

1. Standard Duty (Grade 1, Grade 2, and Grade 3): Side mounted and extending under bottom edge of drawer; partial-extension type; epoxy-coated steel with polymer rollers.
2. Heavy Duty (Grade 1HD-100 and Grade 1HD-200): Side mounted; full-extension type; zinc-plated steel ball-bearing slides.
3. File Drawer Slides: Grade 1HD-100; for drawers more than 6 inches high or 24 inches wide.

4. Pencil Drawer Slides: Grade 2; for drawers not more than 3 inches high and 24 inches wide.

I. Door Locks: BHMA A156.11, E07121.

J. Drawer Locks: BHMA A156.11, E07041.

K. Exposed Hardware Finishes: For exposed hardware, provide finish that complies with BHMA A156.18 for BHMA finish number indicated.

1. Satin Stainless Steel: BHMA 630.

L. For concealed hardware, provide manufacturer's standard finish that complies with product class requirements in BHMA A156.9.

2.04 MISCELLANEOUS MATERIALS

A. Furring, Blocking, Shims, and Hanging Strips: Softwood or hardwood lumber, kiln dried to less than 15 percent moisture content.

B. Furring, Blocking, Shims, and Hanging Strips: Fire-retardant-treated softwood lumber, kiln dried to less than 15 percent moisture content.

C. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage. Provide nonferrous-metal or hot-dip galvanized anchors and inserts on inside face of exterior walls and elsewhere as required for corrosion resistance. Provide toothed-steel or lead expansion sleeves for drilled-in-place anchors.

D. Adhesives, General: Do not use adhesives that contain urea formaldehyde.

E. VOC Limits for Installation Adhesives and Glues: Use installation adhesives that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):

1. Wood Glues: 30 g/L.

2. Contact Adhesive: 250 g/L.

F. Adhesive for Bonding Plastic Laminate: Unpigmented contact cement.

1. Adhesive for Bonding Edges: Hot-melt adhesive or adhesive specified above for faces.

2.05 FABRICATION, GENERAL

A. Interior Woodwork Grade: Unless otherwise indicated, provide Custom-grade interior woodwork complying with referenced quality standard.

B. Wood Moisture Content: Comply with requirements of referenced quality standard for wood moisture content in relation to ambient relative humidity during fabrication and in installation areas.

C. Sand fire-retardant-treated wood lightly to remove raised grain on exposed surfaces before fabrication.

D. Fabricate woodwork to dimensions, profiles, and details indicated. Ease edges to radius indicated for the following:

1. Corners of Cabinets and Edges of Solid-Wood (Lumber) Members 3/4 Inch Thick or Less: 1/16 inch.
 2. Edges of Rails and Similar Members More Than 3/4 Inch Thick: 1/8 inch.
 3. Corners of Cabinets and Edges of Solid-Wood (Lumber) Members and Rails: 1/16 inch.
- E. Complete fabrication, including assembly, finishing, and hardware application, to maximum extent possible before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.
1. Notify Authority seven days in advance of the dates and times woodwork fabrication will be complete.
 2. Trial fit assemblies at fabrication shop that cannot be shipped completely assembled. Install dowels, screws, bolted connectors, and other fastening devices that can be removed after trial fitting. Verify that various parts fit as intended and check measurements of assemblies against field measurements indicated on Shop Drawings before disassembling for shipment.
- F. Shop-cut openings to maximum extent possible to receive hardware, appliances, plumbing fixtures, electrical work, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.
1. Seal edges of openings in countertops with a coat of varnish.

2.06 PLASTIC-LAMINATE CABINETS

- A. Grade: Custom.
- B. AWI Construction Style: As indicated.
- C. AWI Door and Drawer Front Style: As indicated.
- D. Reveal Dimension: As indicated.
- E. Laminate Cladding for Exposed Surfaces: High-pressure decorative laminate complying with the following requirements:
1. Horizontal Surfaces Other Than Tops: Grade HGL.
 2. Postformed Surfaces: Grade HGP.
 3. Vertical Surfaces: Grade VGS.
 4. Edges: Grade VGS.
- F. Concealed Backs of Panels with Exposed Plastic Laminate Surfaces: High-pressure decorative laminate, Grade BKL.
- G. Colors, Patterns, and Finishes: Provide materials and products that result in colors and textures of exposed laminate surfaces complying with the following requirements:
1. As indicated by laminate manufacturer's designations on Finish Legend on Drawings.
- H. Provide dust panels of 1/4-inch plywood or tempered hardboard above compartments and drawers, unless located directly under tops.

2.07 SOLID-SURFACING-MATERIAL COUNTERTOPS

- A. Grade: Custom.
- B. Solid-Surfacing-Material Thickness: 3/4 inch.
- C. Colors, Patterns, and Finishes: Provide materials and products that result in colors of solid-surfacing material indicated by manufacturer's designations on Finish Legend on Drawings.
- D. Fabricate tops in one piece, unless otherwise indicated. Comply with solid-surfacing-material manufacturer's written recommendations for adhesives, sealers, fabrication, and finishing.
 - 1. Fabricate tops with shop-applied edges of materials and configuration indicated.
- E. Drill holes in countertops for plumbing fittings and soap dispensers in shop.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Before installation, condition woodwork to average prevailing humidity conditions in installation areas.
- B. Before installing architectural woodwork, examine shop-fabricated work for completion and complete work as required, including removal of packing and backpriming.

3.02 INSTALLATION

- A. Grade: Install woodwork to comply with requirements for the same grade specified in Part 2 for fabrication of type of woodwork involved.
- B. Assemble woodwork and complete fabrication at Project site to comply with requirements for fabrication in Part 2, to extent that it was not completed in the shop.
- C. Install woodwork level, plumb, true, and straight. Shim as required with concealed shims. Install level and plumb (including tops) to a tolerance of 1/8 inch in 96 inches.
- D. Scribe and cut woodwork to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.
- E. Fire-Retardant-Treated Wood: Handle, store, and install fire-retardant-treated wood to comply with chemical treatment manufacturer's written instructions, including those for adhesives used to install woodwork.
- F. Anchor woodwork to anchors or blocking built in or directly attached to substrates. Secure with countersunk, concealed fasteners and blind nailing as required for complete installation. Use fine finishing nails or finishing screws for exposed fastening, countersunk and filled flush with woodwork and matching final finish if transparent finish is indicated.
- G. Paneling: Anchor paneling to supporting substrate with concealed panel-hanger clips. Do not use face fastening, unless otherwise indicated.
 - 1. Install flush paneling with no more than 1/16 inch in 96-inch vertical cup or bow

and 1/8 inch in 96-inch horizontal variation from a true plane.

- H. Cabinets: Install without distortion so doors and drawers fit openings properly and are accurately aligned. Adjust hardware to center doors and drawers in openings and to provide unencumbered operation. Complete installation of hardware and accessory items as indicated.
 - 1. Install cabinets with no more than 1/8 inch in 96-inch sag, bow, or other variation from a straight line.
 - 2. Maintain veneer sequence matching of cabinets with transparent finish.
 - 3. Fasten wall cabinets through back, near top and bottom, at ends and not more than 16 inches o.c. with No. 10 wafer-head sheet metal screws through metal backing or metal framing behind wall finish.
- I. Countertops: Anchor securely by screwing through corner blocks of base cabinets or other supports into underside of countertop.
 - 1. Align adjacent solid-surfacing-material countertops and form seams to comply with manufacturer's written recommendations using adhesive in color to match countertop. Carefully dress joints smooth, remove surface scratches, and clean entire surface.
 - 2. Install countertops with no more than 1/8 inch in 96-inch sag, bow, or other variation from a straight line.
 - 3. Calk space between backsplash and wall with sealant specified in Division 07 Section "Joint Sealants."
- J. Touch up finishing work specified in this Section after installation of woodwork. Fill nail holes with matching filler where exposed.

3.03 ADJUSTING AND CLEANING

- A. Repair damaged and defective woodwork, where possible, to eliminate functional and visual defects; where not possible to repair, replace woodwork. Adjust joinery for uniform appearance.
- B. Clean, lubricate, and adjust hardware.
- C. Clean woodwork on exposed and semiexposed surfaces. Touch up shop-applied finishes to restore damaged or soiled areas.

END OF SECTION 06 40 23

SECTION 06 64 00**PLASTIC PANELING****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section includes glass-fiber reinforced plastic (FRP) wall paneling and trim accessories.
- B. Locations: As shown on Drawings, including Janitor's Closet.
- C. Related Sections:
 - 1. Section 06 10 53 "Miscellaneous Rough Carpentry" for wood furring for installing plastic paneling.

1.03 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. LEED Submittals:
 - 1. Product Data for Credit IEQ 4.1: For adhesives and sealants, documentation including printed statement of VOC content.
 - 2. Product Data for Credit IEQ 4.4: For laminating adhesive used in factory-laminated plastic panels, documentation indicating that product contains no urea formaldehyde.
- C. Samples for Initial Selection: For plastic paneling and trim accessories.
- D. Samples for Verification: For plastic paneling and trim accessories, in manufacturer's standard sizes.

1.04 QUALITY ASSURANCE

- A. Source Limitations: Obtain plastic paneling and trim accessories from single manufacturer.
- B. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame-Spread Index: 25 or less.
 - 2. Smoke-Developed Index: 450 or less.
 - 3. Testing Agency: Acceptable to authorities having jurisdiction.

1.05 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install plastic paneling until spaces are enclosed and weathertight and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

PART 2 - PRODUCTS

2.01 PLASTIC SHEET PANELING

- A. General: Gelcoat-finished, glass-fiber reinforced plastic panels complying with ASTM D 5319.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Kemlite Company Inc.
 - b. Marlite.
 - c. Nudo Products, Inc.
 - 2. Nominal Thickness: Not less than 0.12 inch.
 - 3. Surface Finish: As selected by Architect from manufacturer's full range.
 - 4. Color: As indicated on Finish Legend.

2.02 ACCESSORIES

- A. Trim Accessories: Manufacturer's standard one-piece vinyl extrusions designed to retain and cover edges of panels. Provide division bars, inside corners, outside corners, and caps as needed to conceal edges.
 - 1. Color: Match panels.
- B. Exposed Fasteners: Nylon drive rivets recommended by panel manufacturer.
- C. Concealed Mounting Splines: Continuous, H-shaped aluminum extrusions designed to fit into grooves routed in edges of factory-laminated panels and to be fastened to substrate.
- D. Adhesive: As recommended by plastic paneling manufacturer.
 - 1. Adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- E. Sealant: Single-component, mildew-resistant, neutral-curing silicone sealant recommended by plastic paneling manufacturer and complying with requirements in Section 07 92 00 "Joint Sealants."
 - 1. Sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Prepare substrate by sanding high spots and filling low spots as needed to provide flat, even surface for panel installation.
- B. Clean substrates of substances that could impair bond of adhesive, including oil, grease, dirt, and dust.
- C. Condition panels by unpacking and placing in installation space before installation according to manufacturer's written recommendations.
- D. Lay out paneling before installing. Locate panel joints to provide equal panels at ends of walls not less than half the width of full panels.
 - 1. Mark plumb lines on substrate at panel joint locations for accurate installation.
 - 2. Locate trim accessories to allow clearance at panel edges according to manufacturer's written instructions.

3.03 INSTALLATION

- A. Install plastic paneling according to manufacturer's written instructions.
- B. Install panels in a full spread of adhesive.
- C. Install panels with fasteners. Layout fastener locations and mark on face of panels so that fasteners are accurately aligned.
 - 1. Drill oversized fastener holes in panels and center fasteners in holes.
 - 2. Apply sealant to fastener holes before installing fasteners.
- D. Install factory-laminated panels using concealed mounting splines in panel joints.
- E. Install trim accessories with adhesive and nails or staples
- F. Fill grooves in trim accessories with sealant before installing panels and bed inside corner trim in a bead of sealant.
- G. Maintain uniform space between panels and wall fixtures. Fill space with sealant.
- H. Maintain uniform space between adjacent panels and between panels and floors, ceilings, and fixtures. Fill space with sealant.
- I. Remove excess sealant and smears as paneling is installed. Clean with solvent recommended by sealant manufacturer and then wipe with clean dry cloths until no residue remains.

END OF SECTION 06 64 00

SECTION 06 74 13**GLASS-FIBER-REINFORCED PLASTIC GRATINGS****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. This Section includes the following:
 - 1. Pultruded glass-fiber-reinforced plastic gratings.
 - 2. Metal frames and supports for gratings.
- B. Locations: As shown on Drawings at exterior pedestrian walkways.
- C. Related Sections include the following:
 - 1. Division 05 Section "Structural Steel Framing" for structural-steel framing system components.
 - 2. Division 05 Section "Metal Stairs" for grating treads and landings of steel-framed stairs.
 - 3. Division 05 Section "Pipe Railings" for metal pipe handrails and railings.

1.03 PERFORMANCE REQUIREMENTS

- A. Structural Performance of Gratings: Provide gratings capable of withstanding the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
 - 1. Floors: Uniform load of 250 lbf/sq. ft. or concentrated load of 3000 lbf, whichever produces the greater stress.
 - 2. Elevated Platforms Other Than Exits: Uniform load of 60 lbf/sq. ft..
 - 3. Walkways and Elevated Platforms at Secondary Buildings: Uniform load of 100 lbf/sq. ft..
 - 4. Limit deflection to $L/240$ or 1/4 inch, whichever is less.
- B. Seismic Performance: Provide gratings capable of withstanding the effects of earthquake motions determined according to ASCE 7, "Minimum Design Loads for Buildings and Other Structures": Section 9, "Earthquake Loads."
- C. Accessibility: Provide gratings that are listed as ADA compliant.

1.04 SUBMITTALS

- A. Product Data: For the following:
 - 1. Glass-fiber-reinforced plastic gratings.
 - 2. Clips and anchorage devices for gratings.
- B. LEED Submittal:
 - 1. Product Data for Credit MR 4.1 and Credit MR 4.2: For products having recycled

content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.

a. Include statement indicating costs for each product having recycled content.

C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Provide templates for anchors and bolts specified for installation under other Sections.

2. For installed products indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

D. Welding certificates.

1.05 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to the following:

1. AWS D1.1, "Structural Welding Code--Steel."

1.06 PROJECT CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with gratings by field measurements before fabrication and indicate measurements on Shop Drawings.

1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating gratings without field measurements. Coordinate wall and other contiguous construction to ensure that actual dimensions correspond to established dimensions.

2. Provide allowance for trimming and fitting at site.

1.07 COORDINATION

A. Coordinate installation of anchorages for gratings, grating frames, and supports. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

PART 2 - PRODUCTS

2.01 GLASS-FIBER-REINFORCED PLASTIC GRATINGS

A. Basis of Design: Provide Aqua Grate T1215 Grating by Fibergrate Composite Structures Inc.

B. Pultruded Glass-Fiber-Reinforced Gratings: Bar gratings assembled from components made by simultaneously pulling glass fibers and extruding thermosetting plastic resin through a heated die under pressure to produce a product without voids and with a high glass-fiber content.

1. Resin Type: Polyester.

a. Flame-Spread Index: 25 or less when tested according to ASTM E 84.

- b. U.S.D.A. Acceptance: Accepted for food processing applications.
- 2. Color:
 - a. For interior installation, Traffic Red RAL 3020
 - b. For exterior installation, as selected by Architect.
- 3. Traffic Surface: Applied abrasive finish.
- C. Fabricate cutouts in grating sections for penetrations indicated. Arrange cutouts to permit grating removal without disturbing items penetrating gratings.

2.02 FASTENERS

- A. General: Unless otherwise indicated, provide Type 316 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 633, Class Fe/Zn 5, at exterior walls. Provide stainless-steel fasteners for fastening aluminum. Select fasteners for type, grade, and class required.
- B. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A; with hex nuts, ASTM A 563; and, where indicated, flat washers.
- C. Stainless-Steel Bolts and Nuts: Regular hexagon-head annealed stainless-steel bolts, nuts, and, where indicated, flat washers; ASTM F 593 for bolts and ASTM F 594 for nuts, Alloy Group 2.
- D. Plain Washers: Round, ASME B18.22.1.
- E. Lock Washers: Helical, spring type, ASME B18.21.1.
- F. Anchors: Provide cast-in-place or torque-controlled expansion anchors with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry and equal to four times the load imposed when installed in concrete, as determined by testing per ASTM E 488 conducted by a qualified independent testing agency.
 - 1. Material for Anchors in Interior Locations: Carbon-steel components zinc-plated to comply with ASTM B 633, Class Fe/Zn 5.
 - 2. Material for Anchors in Exterior Locations: Alloy Group 2 stainless-steel bolts complying with ASTM F 593 and nuts complying with ASTM F 594.

2.03 FABRICATION

- A. Shop Assembly: Fabricate grating sections in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.
- B. Cut, drill, and punch material cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch, unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- C. Form from materials of size, thickness, and shapes indicated, but not less than that needed to support indicated loads.
- D. Fit exposed connections accurately together to form hairline joints.
- E. Provide for anchorage of type indicated; coordinate with supporting structure.

Fabricate and space the anchoring devices to secure gratings, frames, and supports rigidly in place and to support indicated loads.

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

- A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing gratings to in-place construction. Include threaded fasteners for concrete and masonry inserts, through-bolts, lag bolts, and other connectors.
- B. Color-tinting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing gratings. Set units accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.
- C. Provide temporary bracing or anchors in formwork for items that are to be built into concrete or masonry.
- D. Fit exposed connections accurately together to form hairline joints.
- E. Corrosion Protection: Coat concealed surfaces of aluminum that will come into contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.

3.02 INSTALLING GLASS-FIBER-REINFORCED PLASTIC GRATINGS

- A. Comply with manufacturer's written instructions for installing gratings. Use manufacturer's standard stainless-steel anchor clips and hold-down devices for bolted connections.

END OF SECTION 06 74 13

SECTION 07 13 26**SELF-ADHERING SHEET WATERPROOFING****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. This Section includes the following:
 - 1. Rubberized-asphalt sheet waterproofing.
 - 2. HDPE sheet waterproofing.
 - 3. Protection board.
- B. Related Sections include the following:
 - 1. Division 07 Section "Joint Sealants" for joint-sealant materials and installation.

1.03 PERFORMANCE REQUIREMENTS

- A. Provide waterproofing that prevents the passage of water.

1.04 SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, and tested physical and performance properties of waterproofing.
 - 2. Include manufacturer's written instructions for evaluating, preparing, and treating substrate.
- B. LEED Submittals:
 - 1. Product Certificates for Credit MR 5: For products and materials required to comply with requirements for regional materials, certificates indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include statement indicating distance to Project, cost for each regional material, and fraction by weight that is considered regional.
- C. Shop Drawings: Show locations and extent of waterproofing and details of substrate joints and cracks, sheet flashings, penetrations, inside and outside corners, tie-ins with adjoining waterproofing, and other termination conditions.
 - 1. Include setting drawings showing layout, sizes, sections, profiles, and joint details of pedestal-supported concrete pavers.
- D. Samples: For each exposed product and for each color and texture specified, including the following products:

1. 8-by-8-inch square of waterproofing and flashing sheet.
2. 8-by-8-inch square of insulation.
3. 4-by-4-inch square of protection board.

- E. Qualification Data: For Installer.
- F. Field quality-control reports.
- G. Sample Warranties: For special warranties.

1.05 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified installer who is acceptable to waterproofing manufacturer to install manufacturer's products.
- B. Source Limitations: Obtain waterproofing materials through one source from a single manufacturer.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver liquid materials to Project site in original packages with seals unbroken, labeled with manufacturer's name, product brand name and type, date of manufacture, and directions for storing and mixing with other components.
- B. Store liquid materials in their original undamaged packages in a clean, dry, protected location and within temperature range required by waterproofing manufacturer.
- C. Remove and replace liquid materials that cannot be applied within their stated shelf life.
- D. Store rolls according to manufacturer's written instructions.
- E. Protect stored materials from direct sunlight.

1.07 PROJECT CONDITIONS

- A. Environmental Limitations: Apply waterproofing within the range of ambient and substrate temperatures recommended by waterproofing manufacturer. Do not apply waterproofing to a damp or wet substrate.
1. Do not apply waterproofing in rain, fog, or mist.
- B. Maintain adequate ventilation during preparation and application of waterproofing materials.

1.08 WARRANTY

- A. Special Manufacturer's Warranty: Written warranty, signed by waterproofing manufacturer agreeing to replace waterproofing material that does not comply with requirements or that does not remain watertight during specified warranty period.
1. Warranty Period: Three years after date of Substantial Completion.

- B. Special Installer's Warranty: Written waterproofing Installer's warranty, signed by Installer, covering Work of this Section, for warranty period of two years.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
1. HDPE Sheet Waterproofing:
 - a. W. R. Grace & Co.; Preprufe.
 2. Rubberized-Asphalt Sheet Waterproofing:
 - a. Carlisle Corporation, Carlisle Coatings & Waterproofing Div.; CCW miradri 860.

2.02 HDPE SHEET WATERPROOFING

- A. HDPE Sheet for Vertical Applications: 42-mil- thick, uniform, flexible sheets consisting of 16-mil- thick, HDPE sheet coated with a pressure-sensitive rubber adhesive, a protective adhesive coating, and a release liner.
- B. HDPE Sheet for Horizontal Applications: 56-mil- thick, uniform, flexible sheets consisting of 30-mil- thick, HDPE sheet coated with a pressure-sensitive rubber adhesive, a protective adhesive coating, a detackifying surface treatment, an uncoated self-adhering side lap strip, and a release liner.
- C. Physical Properties: As follows, measured per standard test methods referenced:
1. Tensile Strength, Film: 4000 psi minimum; ASTM D 412.
 2. Low-Temperature Flexibility: Pass at minus 10 deg F; ASTM D 1970.
 3. Peel Adhesion to Concrete: 5 lbf/in.; ASTM D 903, modified.
 4. Lap Adhesion: 2.5 lbf/in.; ASTM D 1876, modified.
 5. Hydrostatic-Head Resistance: 231 feet; ASTM D 5385, modified.
 6. Vapor Permeance: 0.01 perms; ASTM E 96, Water Method.

2.03 RUBBERIZED-ASPHALT SHEET WATERPROOFING

- A. Rubberized-Asphalt Sheet: 60-mil- thick, self-adhering sheet consisting of 56 mils of rubberized asphalt laminated to a 4-mil- thick, polyethylene film with release liner on adhesive side [and formulated for application with primer or surface conditioner that complies with VOC limits of authorities having jurisdiction].
1. Physical Properties: As follows, measured per standard test methods referenced:
- a. Tensile Strength: 325 psi minimum; ASTM D 412, Die C, modified.
 - b. Ultimate Elongation: 350 percent minimum; ASTM D 412, Die C, modified.
 - c. Low-Temperature Flexibility: Pass at minus 45 deg F; ASTM D 1970.

- d. Crack Cycling: Unaffected after 100 cycles of 1/8-inch movement; ASTM C 836.
- e. Puncture Resistance: 60 lbf minimum; ASTM E 154.
- f. Hydrostatic-Head Resistance: 230 feet minimum; ASTM D 5385.
- g. Water Absorption: 0.1 percent weight-gain maximum after 48-hour immersion at 70 deg F; ASTM D 570.
- h. Vapor Permeance: 0.05 perms; ASTM E 96, Water Method.

2.04 AUXILIARY MATERIALS

- A. General: Furnish auxiliary materials recommended by waterproofing manufacturer for intended use and compatible with sheet waterproofing.
 - 1. Furnish liquid-type auxiliary materials that comply with VOC limits of authorities having jurisdiction.
- B. Primer: Liquid waterborne primer recommended for substrate by manufacturer of sheet waterproofing material.
- C. Surface Conditioner: Liquid, waterborne surface conditioner recommended for substrate by manufacturer of sheet waterproofing material.
- D. Mastic, Adhesives, and Tape: Liquid mastic and adhesives, and adhesive tapes recommended by waterproofing manufacturer.
 - 1. Detail Tape: Two-sided, pressure-sensitive, self-adhering reinforced tape, 4-1/2 inches wide, with a tack-free protective adhesive coating on one side and release film on self-adhering side.
- E. Protection Course: ASTM D 6506, semirigid sheets of fiberglass or mineral-reinforced-asphaltic core, pressure laminated between two asphalt-saturated fibrous liners and as follows:
 - 1. Thickness: 1/8 inch, nominal, for vertical applications; 1/4 inch, nominal, elsewhere.
 - 2. Adhesive: Rubber-based solvent type recommended by waterproofing manufacturer for protection course type.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance.
 - 1. Verify that compacted subgrade is dry, smooth, and sound; ready to receive HDPE sheet.
 - 2. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 HDPE SHEET APPLICATION

- A. Install HDPE sheets according to waterproofing manufacturer's written instructions.

- B. Horizontal Applications: Install sheet membrane with HDPE face against substrate. Accurately align sheets and maintain uniform 3-inch- minimum lap widths and end laps. Overlap and seal seams. Overlap, stagger, and seal end laps with detail tape to ensure watertight installation.
- C. Corners: Seal lapped terminations and cut edges of sheet waterproofing at inside and outside corners with detail tape.
- D. Seal penetrations through sheet waterproofing to provide watertight seal with detail tape patches or wraps and a liquid-membrane troweling.
- E. Install sheet waterproofing and auxiliary materials to produce a continuous watertight tie into adjacent waterproofing.
- F. Repair tears, voids, and lapped seams in waterproofing not complying with requirements. Tape perimeter of damaged or nonconforming area extending 6 inches beyond repaired areas in all directions. Apply a patch of sheet membrane and firmly secure with detail tape.
- G. Correct deficiencies in or remove waterproofing that does not comply with requirements, repair substrates, reapply waterproofing, and repair sheet flashings.

3.03 RUBBERIZED-ASPHALT SHEET APPLICATION

- A. Install self-adhering sheets according to waterproofing manufacturer's written instructions and recommendations in ASTM D 6135.
- B. Apply primer to substrates at required rate and allow to dry. Limit priming to areas that will be covered by sheet waterproofing in same day. Reprime areas exposed for more than 24 hours.
- C. Apply and firmly adhere sheets over area to receive waterproofing. Accurately align sheets and maintain uniform 2-1/2-inch- minimum lap widths and end laps. Overlap and seal seams and stagger end laps to ensure watertight installation.
 - 1. When ambient and substrate temperatures range between 25 and 40 deg F, install self-adhering, rubberized-asphalt sheets produced for low-temperature application. Do not use low-temperature sheets if ambient or substrate temperature is higher than 60 deg F.
- D. Two-Ply Application: Install sheets to form a membrane with lap widths not less than 50 percent of sheet widths to provide a minimum of 2 thicknesses of sheet membrane over areas to receive waterproofing.
- E. Horizontal Application: Apply sheets from low point to high point of decks to ensure that side laps shed water.
- F. Apply continuous sheets over sheet strips bridging substrate cracks, construction, and contraction joints.
- G. Seal exposed edges of sheets at terminations not concealed by metal counterflashings or ending in reglets with mastic or sealant.

- H. Install sheet waterproofing and auxiliary materials to tie into adjacent waterproofing.
- I. Repair tears, voids, and lapped seams in waterproofing not complying with requirements. Slit and flatten fishmouths and blisters. Patch with sheets extending 6 inches beyond repaired areas in all directions.
- J. Correct deficiencies in or remove sheet waterproofing that does not comply with requirements, repair substrates, reapply waterproofing, and repair sheet flashings.

3.04 PROTECTION AND CLEANING

- A. Do not permit foot or vehicular traffic on unprotected membrane.
- B. Protect waterproofing from damage and wear during remainder of construction period.
- C. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 07 13 26

SECTION 07 21 13**FOAM BOARD FOUNDATION INSULATION****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section Includes foam-plastic board insulation for following applications
1. Adhered to below grade foundation walls.
 2. Applied to earthen grade beneath concrete slabs-on-grade receiving hydronic heating.
- B. Locate each insulation type as indicated in following table:

Location	Foam Plastic Board Insulation Type
Perimeter and field insulation under slabs-on-grade	Extruded-Polystyrene Board Insulation, Type VII (seven)
Perimeter wall insulation (supporting backfill)	Extruded-Polystyrene Board Insulation, Type IV (four)

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. LEED Submittals:
1. Product Data for Credit EA 1: For products indicated to comply with minimum thermal energy performance requirements including resistance, conductance, transmittance, reflectance, and absorption.
 2. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.
 3. Credit EQ 4.1: Manufacturers' product data for adhesive, including printed statement of VOC content.

1.04 QUALITY ASSURANCE

- A. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Protect insulation materials from physical damage and from deterioration due to moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.

- B. Protect foam-plastic board insulation as follows:
1. Do not expose to sunlight except to necessary extent for period of installation and concealment.
 2. Protect against ignition at all times. Do not deliver foam-plastic board materials to Project site before installation time.
 3. Quickly complete installation and concealment of foam-plastic board insulation in each area of construction.

PART 2 - PRODUCTS

2.01 FOAM-PLASTIC BOARD INSULATION

- A. Extruded-Polystyrene Board Insulation: ASTM C 578, of type, minimum compressive strength, density, and thermal resistance indicated below, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, per ASTM E 84.
1. Manufacturers: Subject to compliance with requirements, provide available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. DiversiFoam Products.
 - b. Dow Chemical Company (The).
 - c. Owens Corning.
 - d. Pactiv Building Products.
 2. Type IV:
 - a. Compressive Strength: 25 psi
 - b. Density: 1.60 lb/cu. ft.
 - c. Thermal Resistance at 75 deg F: 4.65/in.
 3. Type VII:
 - a. Compressive Strength: 60 psi
 - b. Density: 2.20 lb/cu. ft.
 - c. Thermal Resistance at 75 deg F: 4.65/in.
 4. Thickness: As indicated on Drawings.
- B. Unfaced Wall Insulation Drainage Panels: Extruded-polystyrene board insulation complying with ASTM C 578, Type IV, 25-psi or Type VI, 40-psi minimum compressive strength; unfaced; fabricated with shiplap or channel edges and with one side having grooved drainage channels.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. DiversiFoam Products.
 - b. Dow Chemical Company (The).
 - c. Pactiv Building Products.
- C. Adhesive for Bonding Insulation to Concrete Foundations: Product with demonstrated capability to bond insulation securely to substrates without damaging insulation and substrates.

1. For field applied adhesives comply with the following VOC requirements:
 - a. Plastic Foam Adhesives: 50 g/L.
- D. Joint Tape: Pressure-sensitive plastic tape recommended by insulation manufacturer for sealing joints and minor penetrations in board insulation.
 1. Tape Width: 2-7/8 inches minimum.
 2. Products: Dow Chemical Company (The); WEATHERMATE Construction Tape or comparable product by another manufacturer.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Clean substrates of substances that are harmful to insulation or that interfere with insulation attachment.

3.02 INSTALLATION, GENERAL

- A. Comply with insulation manufacturer's written instructions applicable to products and applications indicated.
- B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed to ice, rain, or snow at any time.
- C. Extend insulation to envelop or cover entire area to be insulated. Cut and fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.
- D. Provide sizes to fit applications indicated and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units to produce thickness indicated unless multiple layers are otherwise shown or required to make up total thickness.

3.03 INSTALLATION OF BELOW-GRADE INSULATION

- A. On vertical surfaces, set insulation units using manufacturer's recommended adhesive according to manufacturer's written instructions.
- B. On horizontal surfaces, loosely lay insulation units according to manufacturer's written instructions.
 1. Stagger end joints and tightly abut insulation units.
 2. Seal seams and penetrations with joint tape centered over joints.

3.04 PROTECTION

- A. Protect installed insulation from damage due to harmful weather exposures, physical abuse, and other causes. Provide temporary coverings or enclosures where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

END OF SECTION 07 21 13

SECTION 07 21 14**CONTINUOUS MINERAL BOARD WALL INSULATION****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section Includes continuous mineral-wool board thermal insulation applied to outboard side of exterior wall sheathing over weather barrier for applications including following:
 - 1. Metal stud exterior wall framing receiving metal plate wall panels.
 - 2. Metal stud exterior wall framing receiving cementitious façade panels.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. LEED Submittals:
 - 1. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.

1.04 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each product.

1.05 QUALITY ASSURANCE

- A. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Protect insulation materials from physical damage and from deterioration due to moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.

PART 2 - PRODUCTS**2.01 MINERAL-WOOL BOARD INSULATION**

- A. Unfaced, Mineral-Wool Board Insulation: ASTM C 612; with maximum flame-spread and smoke-developed indexes of zero and zero, respectively, per ASTM E 84;

passing ASTM E 136 for combustion characteristics.

1. R Value: Minimum 8.7 for 2 inch thickness.
2. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 70 percent.
3. Available Products: Subject to compliance with requirements, provide one of the following:
 - a. Roxul; CavityRock DD (dual density).
 - b. Thermafiber; RainBarrier 45.
4. Fiber Color: Provide darkened material on walls receiving cementitious façade panels.

2.02 INSULATION FASTENERS

- A. Fasteners for Fastening Insulation to Cold-Formed Metal Framing: Provide screws with plastic cap washers.
 1. Screws: Steel drill screws with organic-polymer or other corrosion-protective coating having a salt-spray resistance of more than 800 hours according to ASTM B 117.
 - a. Length: As required to produce not less than 3 screw threads visible on backside of face of metal stud.
 - b. For steel framing less than 0.0329 inch thick, use screws that comply with ASTM C 1002.
 - c. For steel framing from 0.033 to 0.112 inch thick, use screws that comply with ASTM C 954.
 2. Plastic Cap Washers: Approximately 1 inch o.d. with fastener hole in center.
 - a. Product: Ideal Security Inc.; Plastic Cap Washer SKPHC or comparable product by another manufacturer.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Clean substrates of substances that are harmful to insulation or that interfere with insulation attachment.

3.02 INSTALLATION

- A. Comply with insulation manufacturer's written instructions applicable to products and applications indicated.
- B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed to ice, rain, or snow at any time.
- C. Extend insulation to envelop entire area to be insulated. Cut and fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.
- D. Provide sizes to fit applications indicated and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units to produce thickness indicated.

- E. Apply insulation units to substrates by method indicated, complying with manufacturer's written instructions. If no specific method is indicated, bond units to substrate with adhesive or use mechanical anchorage to provide permanent placement and support of units.
- F. Apply insulation units to substrates as follows:
 - 1. For metal stud wall framing, hold insulation in place by securing with metal screws with plastic caps specified, spaced at intervals recommended in writing by insulation manufacturer to hold insulation securely in place, but not greater than 24 inches o.c. Avoid compressing insulation with fasteners.
 - 2. Where indicated, Z-furring members may be used to retain edges of insulation in lieu of fasteners.

3.03 PROTECTION

- A. Protect installed insulation from damage due to harmful weather exposures, physical abuse, and other causes. Provide temporary coverings or enclosures where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

END OF SECTION 07 21 14

SECTION 07 21 16
BLANKET INSULATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:

1. Glass-fiber blanket insulation.
2. Mineral-wool blanket insulation.

B. Related Sections:

1. Division 06 Section "Sheathing" for glass mat sheathing over steel framing.
2. Division 07 Section "Thermoplastic Polyolefin (TPO) Roofing" for insulation specified as part of roofing construction.
3. Division 07 Section "Fire-Resistive Joint Systems" for insulation installed as part of a perimeter fire-resistive joint system.

1.03 SUBMITTALS

- A. Product Data: For each type of product indicated.

B. LEED Submittals:

1. Product Data for Credit MR 4.1 and Credit MR 4.2: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating costs for each product having recycled content.
2. Product Data for Credit EQ 4.1: For sealants, including printed statement of VOC content.
3. Product Data for Credit EQ 4.1: For adhesives, including printed statement of VOC content.

- C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each product.

1.04 QUALITY ASSURANCE

- A. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Protect insulation materials from physical damage and from deterioration due to moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.

PART 2 - PRODUCTS

2.01 GLASS-FIBER BLANKET INSULATION

- A. Performance Criteria: Minimum R3 per inch thickness.
- B. Recycled Content of Blanket Insulation: Provide products with average recycled content of products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than 20 percent.
- C. Regional Materials: Provide glass-fiber blanket insulation that has been manufactured within 500 miles of Project site from raw materials that have been extracted or recovered, as well as manufactured, within 500 miles of Project site.
- D. Sustainability Requirements: Provide glass-fiber blanket insulation as follows:
 - 1. Free of Formaldehyde: Insulation manufactured with 100 percent acrylic binders and no formaldehyde.
 - 2. Low Emitting: Insulation tested according to ASTM D 5116 and shown to emit less than 0.05-ppm formaldehyde.
- E. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. CertainTeed Corporation.
 - 2. Guardian Building Products, Inc.
 - 3. Johns Manville.
 - 4. Knauf Insulation.
 - 5. Owens Corning.
- F. Unfaced, Glass-Fiber Blanket Insulation: ASTM C 665, Type I; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively, per ASTM E 84; passing ASTM E 136 for combustion characteristics.
- G. Reinforced-Foil-Faced, Glass-Fiber Blanket Insulation: ASTM C 665, Type III (reflective faced), Class A (faced surface with a flame-spread index of 25 or less); Category 1 (membrane is a vapor barrier), faced with foil scrim, foil-scrim kraft, or foil-scrim polyethylene.
- H. Foil-Faced, Glass-Fiber Blanket Insulation: ASTM C 665, Type III (reflective faced), Class B (faced surface with a flame-propagation resistance of 0.12 W/sq. cm); Category 1 (membrane is a vapor barrier), faced with foil scrim, foil-scrim kraft, or foil-scrim polyethylene.

2.02 MINERAL-WOOL BLANKET INSULATION

- A. Performance Criteria: Minimum R3 per inch thickness.
- B. Recycled Content of Blanket Insulation: Provide products with average recycled content of products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than 70 percent.
- C. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Fibrex Insulations Inc.
 - 2. Owens Corning.

3. Roxul Inc.
 4. Thermafiber.
- D. Unfaced, Mineral-Wool Blanket Insulation: ASTM C 665, Type I (blankets without membrane facing); consisting of fibers; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively, per ASTM E 84; passing ASTM E 136 for combustion characteristics.
- E. Reinforced-Foil-Faced, Mineral-Wool Blanket Insulation: ASTM C 665, Type III (reflective faced), Class A (faced surface with a flame-spread index of 25 or less per ASTM E 84); Category 1 (membrane is a vapor barrier), faced with foil scrim, foil-scrim kraft, or foil-scrim polyethylene.

2.03 INSULATION FASTENERS

- A. Adhesively Attached, Spindle-Type Anchors: Plate welded to projecting spindle; capable of holding insulation of specified thickness securely in position indicated with self-locking washer in place.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. AGM Industries, Inc.; Series T TACTOO Insul-Hangers.
 - b. Gemco; Spindle Type.
 2. Plate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
 3. Spindle: Copper-coated, low-carbon steel; fully annealed; 0.105 inch in diameter; length to suit depth of insulation indicated.
- B. Adhesively Attached, Angle-Shaped, Spindle-Type Anchors: Angle welded to projecting spindle; capable of holding insulation of specified thickness securely in position indicated with self-locking washer in place.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Gemco; 90-Degree Insulation Hangers.
 2. Angle: Formed from 0.030-inch- thick, perforated, galvanized carbon-steel sheet with each leg 2 inches square.
 3. Spindle: Copper-coated, low-carbon steel; fully annealed; 0.105 inch in diameter; length to suit depth of insulation indicated.
- C. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick galvanized-steel sheet, with beveled edge for increased stiffness, sized as required to hold insulation securely in place, but not less than 1-1/2 inches square or in diameter.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. AGM Industries, Inc.; RC150 or SC150.
 - b. Gemco; R-150 or S-150.
 2. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in the following locations:
 - a. Crawl spaces.
 - b. Ceiling plenums.
 - c. Where indicated.

- D. Insulation Standoff: Spacer fabricated from galvanized mild-steel sheet for fitting over spindle of insulation anchor to maintain air space of 1 inch minimum between face of insulation and substrate to which anchor is attached.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Gemco; Clutch Clip.
- E. Anchor Adhesive: Product with demonstrated capability to bond insulation anchors securely to substrates indicated without damaging insulation, fasteners, and substrates.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. AGM Industries, Inc.; TACTOO Adhesive.
 - b. Gemco; Tuff Bond Hanger Adhesive.
 - c. Michigan Adhesive Manufacturing; Seal Bond 95.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Clean substrates of substances that are harmful to insulation or vapor retarders, including removing projections capable of puncturing vapor retarders, or that interfere with insulation attachment.

3.02 INSTALLATION, GENERAL

- A. Comply with insulation manufacturer's written instructions applicable to products and applications indicated.
- B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed to ice, rain, or snow at any time.
- C. Extend insulation to envelop entire area to be insulated. Cut and fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.
- D. Provide sizes to fit applications indicated and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units to produce thickness indicated unless multiple layers are otherwise shown or required to make up total thickness.

3.03 INSTALLATION OF INSULATION FOR FRAMED CONSTRUCTION

- A. Apply insulation units to substrates by method indicated, complying with manufacturer's written instructions. If no specific method is indicated, bond units to substrate with adhesive or use mechanical anchorage to provide permanent placement and support of units.
- B. Glass-Fiber or Mineral-Wool Blanket Insulation: Install in cavities formed by framing members according to the following requirements:
 1. Use insulation widths and lengths that fill the cavities formed by framing members. If more than one length is required to fill the cavities, provide lengths that will produce a snug fit between ends.
 2. Place insulation in cavities formed by framing members to produce a friction fit

- between edges of insulation and adjoining framing members.
3. Maintain **3-inch** clearance of insulation around recessed lighting fixtures not rated for or protected from contact with insulation.
 4. For metal-framed wall cavities where cavity heights exceed **96 inches**, support unfaced blankets mechanically and support faced blankets by taping flanges of insulation to flanges of metal studs.
 5. Vapor-Retarder-Faced Blankets: Tape joints and ruptures in vapor-retarder facings, and seal each continuous area of insulation to ensure airtight installation.
 - a. Exterior Walls: Set units with facing placed toward interior of construction.
 - b. Interior Walls: Set units with facing placed toward areas of high humidity.
- C. Miscellaneous Voids: Install insulation in miscellaneous voids and cavity spaces where required to prevent gaps in insulation using the following materials:
1. Loose-Fill Insulation: Compact to approximately 40 percent of normal maximum volume equaling a density of approximately **2.5 lb/cu. ft.**

3.04 INSTALLATION OF INSULATION IN CEILINGS FOR SOUND ATTENUATION

- A. Where glass-fiber blankets are indicated for sound attenuation above ceilings, install blanket insulation over entire ceiling area in thicknesses indicated. Extend insulation **48 inches** up either side of partitions.

3.05 INSTALLATION OF INSULATION FOR CONCRETE SUBSTRATES

- A. Install blanket insulation on concrete substrates by adhesively attached, spindle-type insulation anchors as follows:
1. Fasten insulation anchors to concrete substrates with insulation anchor adhesive according to anchor manufacturer's written instructions. Space anchors according to insulation manufacturer's written instructions for insulation type, thickness, and application indicated.
 2. Apply insulation standoffs to each spindle to create cavity width indicated between concrete substrate and insulation.
 3. After adhesive has dried, install blanket insulation by pressing insulation into position over spindles and securing it tightly in place with insulation-retaining washers, taking care not to compress insulation below indicated thickness.
 4. Where insulation will not be covered by other building materials, apply capped washers to tips of spindles.

3.06 PROTECTION

- A. Protect installed insulation and vapor retarders from damage due to harmful weather exposures, physical abuse, and other causes. Provide temporary coverings or enclosures where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.
- B. Construction Waste Management and Disposal:
1. Comply with Waste Management Plan required under Division 01 Section "Construction Waste Management And Disposal."

END OF SECTION 07 21 16

**SECTION 07 25 00
WEATHER BARRIERS****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Vapor-permeable water-resistive barrier.

1.03 RELATED REQUIREMENTS

- A. Division 06 Section "Sheathing" for exterior wall sheathing substrate for weather barrier.

1.04 REFERENCE STANDARDS

- A. American Association of Textile Chemists and Colorists (AATCC):
 - 1. AATCC 127 - Test Method for Water Resistance: Hydrostatic Pressure Test.
- B. ASTM International (ASTM):
 - 1. ASTM D412 - Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers-Tension
 - 2. ASTM D570 - Standard Test Method for Water Absorption of Plastics.
 - 3. ASTM D 882 - Test Method for Tensile Properties of Thin Plastic Sheeting.
 - 4. ASTM D903 - Standard Test Method for Peel or Stripping Strength of Adhesive Bonds.
 - 5. ASTM D1970 - Standard Specification for Self-Adhering Polymer Modified Bituminous Sheet Materials Used as Steep Roofing Underlayment for Ice Dam Protection
 - 6. ASTM E 84 - Test Method for Surface Burning Characteristics of Building Materials
 - 7. ASTM E 96/E 96M - Test Methods for Water Vapor Transmission of Materials
 - 8. ASTM E2178-01 - Standard Test Method for Air Permeance of Building Materials
- C. International Code Council Evaluation Service, Inc. (ICC-ES):
 - 1. ICC-ES AC38 - Acceptance Criteria for Water-Resistive Barriers.

1.05 QUALITY ASSURANCE

- A. Single Source: Provide water-resistive barrier and accessories that are products of or recommended for use by a single manufacturer.
- B. Manufacturer Qualifications: Approved manufacturer of products listed in this Section with minimum 5 years experience in manufacture of similar products in successful use in similar applications.

1. Approval of Comparable Products: Submit the following in accordance with project substitution requirements, within time allowed for substitution review:
 - a. Product data, including certified independent test data indicating compliance with requirements.
 - b. Samples of each component.
 - c. Sample warranty.
 - d. Substitutions following award of contract are not allowed except as stipulated in Division 01 General Requirements.
- C. Fire Performance Characteristics: Provide water-resistive barrier with the following fire-test characteristics.
 1. Surface-Burning Characteristics: ASTM E 84.
 - a. Flame spread index: 25 or less.
 - b. Smoke developed index: 450 or less.
 - c. Mockups: Build mockup in size and location indicated on Drawings. Show details of water-resistive barrier. Demonstrate methods and details of installation. Show details of joints, penetrations, openings, inside and outside corners, and top and bottom of wall.
 2. Perform water spray test of mockup to demonstrate performance.

1.06 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Meeting: Conduct preinstallation meeting at site attended by Installer, affected trade contractors, and inspector.
 1. Include Architect and Owner.
 2. Coordinate substrate installation in relation to requirements for water-resistive barrier.
 3. Coordinate window, door, and other openings and penetrations of water-resistive barrier.
 4. Review mockup.

1.07 SUBMITTALS

- A. Product Data: Manufacturer's data sheets for specified products. Include data indicating compliance with requirements of this Section.
 1. Provide manufacturer's standard installation instructions and details for water-resistive barrier and accessories.
- B. Samples: Submit samples of the following:
 1. Water-resistive barrier sheet, minimum 10 by 10 inches.
 2. Membrane flashings and tapes.
 3. Fasteners.
 4. Sealants.
- C. Evaluation Report: For water-resistive barrier, from ICC-ES.

- D. Manufacturer's warranty: Submit sample warranty.

1.08 WARRANTY

- A. Special Manufacturer's Warranty: On manufacturer's standard form, in which manufacturer agrees to provide replacement material for water-resistive barrier installed in accordance with manufacturer's instructions that fails due to material defects within 20 years from date of purchase.

PART 2 - PRODUCTS

2.01 WATER-RESISTIVE BARRIER

- A. Building Wrap: ASTM E 1677, Type I air barrier; with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, when tested according to ASTM E 84; UV stabilized; and acceptable to authorities having jurisdiction.
1. Basis of Design: Subject to requirements, provide Tyvek Commercial Wrap by DuPont or an approved product by one of the following:
 - a. Dow Chemical Company (The.
 - b. Pactiv, Inc.; .
 - c. Raven Industries Inc.
 2. Water-Vapor Permeance: Not less than 28 perms per ASTM E 96/E 96M, Desiccant Method (Procedure A).
 3. Air Permeance: Not more than 0.004 cfm/sq. ft. at 0.3-inch wg when tested according to ASTM E 2178.
 4. Allowable UV Exposure Time: Not less than three months.
- B. Building-Wrap Tape: Pressure-sensitive plastic tape recommended by building-wrap manufacturer for sealing joints and penetrations in building wrap.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Examine substrate with Installer present for compliance with requirements and other conditions that would adversely affect installation or performance of weather resistive barrier. Correct deficient conditions prior to proceeding with water-resistive barrier installation.

3.02 SUBSTRATE PREPARATION

- A. Clean and prepare substrate according to manufacturer's written recommendations. Provide clean and dry substrate for breathable membrane application.

3.03 WATER-RESISTIVE BARRIER INSTALLATION

- A. General: Install water-resistive barrier in accordance with manufacturer's instructions over exterior sheathing. Secure water-resistive barrier to substrate to prevent damage prior to installation of cladding.

B. Window and Louver Openings

1. Secure prefabricated sill pan and water-resistive barrier corners at sill of opening.
2. Install lap strip of water-resistive barrier across sill and secure with tape or mechanical fasteners, leaving bottom of lap strip free to overlap water-resistive barrier minimum of 6 inches.
3. Install lap strip water-resistive barrier around jambs, extending along wall surface a minimum of 9 inches.
4. Secure prefabricated water-resistive barrier corners at head of opening.
5. Install lap strip of water-resistive barrier across head of opening, extending horizontally beyond corners minimum of 6 inches.
6. Cut water-resistive barrier along leading edge of header 2 inches beyond jamb to allow insertion of window nailing flange behind weather barrier.

C. Door Openings

1. Install water-resistive barrier lap strip around jambs, extending along wall surface a minimum of 9 inches.
2. Secure prefabricated water-resistive barrier corners at head of opening.
3. Install lap strip of water-resistive barrier across head of opening, extending horizontally beyond corners minimum of 6 inches.
4. Cut water-resistive barrier along leading edge of header 2 inches beyond jamb to allow insertion of door nailing flange behind weather barrier.

D. Pipe and Conduit Penetrations

1. Install manufactured penetration sleeves sized for penetration and installed as recommended by sleeve manufacturer.
2. Prepare water-resistive barrier skirt with minimum 12 inches of fabric on all sides at counter-flashed penetrations. Make multiple cuts to form a star-shaped opening in fabric and place over penetration. Extend skirt fabric along penetrating item and seal to penetrating item with single-sided tape.

E. Water-Resistive Barrier

1. Begin water-resistive barrier installation at bottom of wall, mechanically fastening water-resistive barrier at bottom and top at 24 inches o.c. Seal bottom edge of water-resistive barrier to substrate in continuous bead of non-skinning butyl sealant or butyl tape.
2. Install water-resistive barrier at overlapped lap strips and penetration skirts. Overlap at vertical laps minimum of 6 inches with taped joints or 12 inches without tape. Overlap at horizontal laps minimum of 6 inches. Insert water-resistive barrier under bottom edge of lap strips and penetration skirts; do not tape bottom edge of skirts and lap strips.
3. Extend water-resistive barrier 6 inches over corners.
4. Shingle subsequent courses of water-resistive barrier. Do not place vertical laps above openings.
5. Use additional mechanical fasteners in field of sheet and tape joints if water-resistive barrier will be left exposed prior to installation of cladding.

3.04 FIELD QUALITY CONTROL

- A. Engage independent inspector to inspect substrate, observe installation, and inspect and document completed water-resistive barrier prior to concealment. Submit photo documentation and written report of inspections.

3.05 PROTECTING AND CLEANING

- A. Protect installed water-resistive barrier from damage due to construction activities, high wind conditions, and extended exposure to weather.
- B. Inspect exposed water-resistive barrier prior to installation of cladding. Remove water-resistive barrier materials that have been damaged and replace. Patch damaged areas as recommended by manufacturer.

END OF SECTION 07 25 00

SECTION 07 42 13**CONCEALED-FASTENER LAP SEAM METAL WALL PANELS****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section Includes concealed-fastener, lap-seam metal wall panels.
- B. Related Sections:
 - 1. Section 05 40 00 "Cold-Formed Metal Framing" for support framing, including girts, studs, and bracing.
 - 2. Section 07 25 00 "Weather Barriers" for continuous air barrier systems.
 - 3. Section 07 42 16 "Insulated Core Metal Wall Panels" for metal panels with honeycomb core.
 - 4. Section 07 62 00 "Sheet Metal Flashing and Trim" for flashing and other sheet metal work that is not part of metal wall panel assemblies.

1.03 DEFINITION

- A. Metal Wall Panel Assembly: Metal wall panels, attachment system components, miscellaneous metal framing, thermal insulation, and accessories necessary for a complete weathertight wall system.

1.04 PERFORMANCE REQUIREMENTS

- A. General Performance: Metal wall panel assemblies shall comply with performance requirements without failure due to defective manufacture, fabrication, installation, or other defects in construction.
- B. Air Infiltration: Air leakage through assembly of not more than **0.06 cfm/sq. ft** of wall area when tested according to ASTM E 283 at the following test-pressure difference:
 - 1. Test-Pressure Difference: **1.57 lbf/sq. ft.**
- C. Water Penetration under Static Pressure: No water penetration when tested according to ASTM E 331 at the following test-pressure difference:
 - 1. Test-Pressure Difference: **6.24 lbf/sq. ft.**
- D. Structural Performance: Provide metal wall panel assemblies capable of withstanding the effects the following loads and stresses within limits and under conditions indicated, based on testing according to ASTM E 1592:
 - 1. Wind Loads: Determine loads based on the following minimum design wind pressures:
 - a. Uniform pressure as indicated on Drawings.
 - 2. Deflection Limits: Metal wall panel assemblies shall withstand wind loads with

horizontal deflections no greater than 1/180 of the span.

- E. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
 - 1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

1.05 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of wall panel and accessory.
- B. Shop Drawings: Show fabrication and installation layouts of metal wall panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details. Distinguish between factory-, shop- and field-assembled work.
 - 1. Accessories: Include details of the following items, at a scale of not less than 1-1/2 inches per 12 inches:
 - a. Flashing and trim.
 - b. Anchorage systems.
- C. Samples for Initial Selection: For each type of metal wall panel indicated with factory-applied color finishes.
 - 1. Include similar Samples of trim and accessories involving color selection.
- D. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below.
 - 1. Metal Wall Panels: 12 inches long by actual panel width. Include fasteners, closures, and other metal wall panel accessories.
 - 2. Trim and Closures: 12 inches long. Include fasteners and other exposed accessories.
 - 3. Accessories: 12-inch- long Samples for each type of accessory.

1.06 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Exterior elevations drawn to scale and coordinating penetrations and wall-mounted items. Show the following:
 - 1. Wall panels and attachments.
 - 2. Girts.
 - 3. Wall-mounted items including doors, windows, louvers, and lighting fixtures.
 - 4. Penetrations of wall by pipes and utilities.
- B. Qualification Data: For Installer and testing agency.
- C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each product.
- D. Field quality-control reports.

E. Warranties: Sample of special warranties.

1.07 CLOSEOUT SUBMITTALS

A. Maintenance Data: For metal wall panels to include in maintenance manuals.

1.08 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers trained and approved by manufacturer.

B. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.

C. Source Limitations: Obtain each type of metal wall panel from single source from single manufacturer.

D. Fire-Resistance Ratings: Where indicated, provide metal wall panels identical to those of assemblies tested for fire resistance per ASTM E 119 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

E. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.

1. Build mockup of typical corner panel as shown on Drawings; approximately one bay wide by one story high by full thickness, including insulation, supports, attachments, and accessories.

2. Conduct water spray test of mockup of metal wall panel assembly, testing for water penetration according to AAMA 501.2.

3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

4. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

F. Preinstallation Conference: Conduct conference at Project site.

1. Meet with Owner, Architect, Owner's insurer if applicable, testing and inspecting agency representative, metal wall panel Installer, metal wall panel manufacturer's representative, structural-support Installer, and installers whose work interfaces with or affects metal wall panels, including installers of doors, windows, and louvers.

2. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.

3. Review methods and procedures related to metal wall panel installation, including manufacturer's written instructions.

4. Examine support conditions for compliance with requirements, including alignment between and attachment to structural members.

5. Review flashings, special siding details, wall penetrations, openings, and condition of other construction that will affect metal wall panels.

6. Review governing regulations and requirements for insurance, certificates, and tests and inspections if applicable.

7. Review temporary protection requirements for metal wall panel assembly during

and after installation.

8. Review wall panel observation and repair procedures after metal wall panel installation.

1.09 DELIVERY, STORAGE, AND HANDLING

- A. Deliver components, sheets, metal wall panels, and other manufactured items so as not to be damaged or deformed. Package metal wall panels for protection during transportation and handling.
- B. Unload, store, and erect metal wall panels in a manner to prevent bending, warping, twisting, and surface damage.
- C. Stack metal wall panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal wall panels to ensure dryness, with positive slope for drainage of water. Do not store metal wall panels in contact with other materials that might cause staining, denting, or other surface damage.
- D. Retain strippable protective covering on metal wall panel for period of metal wall panel installation.
- E. Protect foam-plastic insulation as follows:
 1. Do not expose to sunlight, except to extent necessary for period of installation and concealment.
 2. Protect against ignition at all times. Do not deliver foam-plastic insulation materials to Project site before installation time.
 3. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

1.10 PROJECT CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of metal wall panels to be performed according to manufacturers' written instructions and warranty requirements.
- B. Field Measurements: Verify locations of structural members and wall opening dimensions by field measurements before metal wall panel fabrication, and indicate measurements on Shop Drawings.

1.11 COORDINATION

- A. Coordinate metal wall panel assemblies with rain drainage work, flashing, trim, and construction of girts, studs, soffits, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.12 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal wall panel assemblies that fail in materials or workmanship within specified warranty period.
 1. Failures include, but are not limited to, the following:
 - a. Structural failures including rupturing, cracking, or puncturing.
 - b. Deterioration of metals and other materials beyond normal weathering.
 2. Warranty Period: Two years from date of Substantial Completion.

- B. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal wall panels that show evidence of deterioration of factory-applied finishes within specified warranty period.
1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
 - b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
 2. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 PANEL MATERIALS

- A. Aluminum Sheet: Coil-coated sheet, [ASTM B 209](#), alloy as standard with manufacturer, with temper as required to suit forming operations and structural performance required.
1. Surface: Smooth, flat finish.
 2. Exposed Coil-Coated Finish:
 - a. 3-Coat Fluoropolymer: AAMA 620. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 3. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish consisting of prime coat and wash coat with a minimum total dry film thickness of [0.5 mil](#).
- B. Panel Sealants:
1. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape [1/2 inch](#) wide and [1/8 inch](#) thick.
 2. Joint Sealant: [ASTM C 920](#); elastomeric polyurethane, polysulfide, or silicone sealant; of type, grade, class, and use classifications required to seal joints in metal wall panels and remain weathertight; and as recommended in writing by metal wall panel manufacturer.
 3. Butyl-Rubber-Based, Solvent-Release Sealant: [ASTM C 1311](#).

2.02 FIELD-INSTALLED THERMAL INSULATION

- A. Refer to Division 07 insulation sections.

2.03 MISCELLANEOUS METAL FRAMING

- A. Miscellaneous Metal Framing, General: [ASTM C 645](#), cold-formed metallic-coated steel sheet, [ASTM A 653/A 653M](#), [G60](#) hot-dip galvanized or coating with equivalent corrosion resistance unless otherwise indicated.
- B. Subgirts: Manufacturer's standard C- or Z-shaped sections, [0.064-inch](#) nominal thickness.

- C. Zee Clips: 0.079-inch nominal thickness.
- D. Base or Sill Angles: 0.079-inch nominal thickness.
- E. Hat-Shaped, Rigid Furring Channels:
 - 1. Nominal Thickness: As required to meet performance requirements.
 - 2. Depth: As indicated.
- F. Cold-Rolled Furring Channels: Minimum 1/2-inch- wide flange.
 - 1. Nominal Thickness: 0.064 inch.
 - 2. Depth: 3/4 inch.
 - 3. Furring Brackets: Adjustable, corrugated-edge type of steel sheet with 0.040-inch nominal thickness.
 - 4. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.062-inch-diameter wire, or double strand of 0.048-inch- diameter wire.
- G. Z-Shaped Furring: With slotted or nonslotted web, face flange of 1-1/4 inches, wall attachment flange of 7/8 inch, and depth required to fit insulation thickness indicated.
 - 1. Nominal Thickness: 0.025 inch.
- H. Fasteners for Miscellaneous Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten miscellaneous metal framing members to substrates.

2.04 MISCELLANEOUS MATERIALS

- A. Panel Fasteners: Self-tapping screws, bolts, nuts, self-locking rivets and bolts, end-welded studs, and other suitable fasteners designed to withstand design loads. Provide exposed fasteners with heads matching color of metal wall panels by means of plastic caps or factory-applied coating. Provide EPDM, PVC, or neoprene sealing washers.

2.05 CONCEALED-FASTENER, LAP-SEAM METAL WALL PANELS

- A. General: Provide factory-formed metal wall panels designed to be field assembled by lapping and interconnecting side edges of adjacent panels and mechanically attaching through panel to supports using concealed fasteners and factory-applied sealant in side laps. Include accessories required for weathertight installation.
- B. Tapered-Rib-Profile, Concealed-Fastener Metal Wall Panels: Formed with raised, trapezoidal major ribs.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide EX160 Aluminum Wall Panel System by Merchant and Evans, Inc., or comparable product by one of the following:
 - a. ATAS International, Inc.
 - b. Dimensional Metals, Inc.
 - c. Metal Sales Manufacturing Corporation.
 - d. Metecno-Morin.
 - 2. Material: Aluminum-zinc alloy-coated steel sheet, 0.028-inch nominal thickness.
 - a. Exterior Finish: 3-coat fluoropolymer.
 - b. Color: Dark grey to match Architect's sample.

3. Panel Coverage: 16 inches.
4. Panel Height: 1 – 5/16 inches

2.06 ACCESSORIES

- A. Wall Panel Accessories: Provide components required for a complete metal wall panel assembly including trim, copings, fasciae, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal wall panels, unless otherwise indicated.
 1. Closures: Provide closures at eaves and rakes, fabricated of same metal as metal wall panels.
 2. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
 3. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch- thick, flexible closure strips; cut or premolded to match metal wall panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.
- B. Flashing and Trim: Formed from 0.018-inch minimum thickness, zinc-coated (galvanized) steel sheet or aluminum-zinc alloy-coated steel sheet prepainted with coil coating. Provide flashing and trim as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, bases, drips, sills, jambs, corners, endwalls, framed openings, rakes, fasciae, parapet caps, soffits, reveals, and fillers. Finish flashing and trim with same finish system as adjacent metal wall panels.

2.07 FABRICATION

- A. General: Fabricate and finish metal wall panels and accessories at the factory to greatest extent possible, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.
- B. Fabricate metal wall panels in a manner that eliminates condensation on interior side of panel and with joints between panels designed to form weathertight seals.
- C. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.
- D. Fabricate metal wall panel joints with factory-installed captive gaskets or separator strips that provide a tight seal and prevent metal-to-metal contact, and that will minimize noise from movements within panel assembly.
- E. Sheet Metal Accessories: Fabricate flashing and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to the design, dimensions, metal, and other characteristics of item indicated.
 1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
 2. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.
 3. Seams for Other Than Aluminum: Fabricate nonmoving seams in accessories with flat-lock seams. Tin edges to be seamed, form seams, and solder.
 4. Sealed Joints: Form nonexpansion but movable joints in metal to accommodate elastomeric sealant to comply with SMACNA standards.

5. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.
6. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended by metal wall panel manufacturer.
 - a. Size: As recommended by SMACNA's "Architectural Sheet Metal Manual" or metal wall panel manufacturer for application but not less than thickness of metal being secured.

2.08 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal wall panel supports, and other conditions affecting performance of work.
 1. Examine wall framing to verify that girts, angles, channels, studs, and other structural panel support members and anchorage have been installed within alignment tolerances required by metal wall panel manufacturer.
 2. Examine wall sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required by metal wall panel manufacturer.
 3. Verify that weather-resistant sheathing paper has been installed over sheathing or backing substrate to prevent air infiltration or water penetration.
 4. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of work.
- B. Examine roughing-in for components and systems penetrating metal wall panels to verify actual locations of penetrations relative to seam locations of metal wall panels before metal wall panel installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Miscellaneous Framing: Install subgirts, base angles, sills, furring, and other miscellaneous wall panel support members and anchorages according to ASTM C 754 and metal wall panel manufacturer's written recommendations.

3.03 METAL WALL PANEL INSTALLATION

- A. General: Install metal wall panels according to manufacturer's written instructions in orientation, sizes, and locations indicated on Drawings. Install panels perpendicular to girts and subgirts unless otherwise indicated. Anchor metal wall panels and other components of the Work securely in place, with provisions for thermal and structural movement.
1. Commence metal wall panel installation and install minimum of 300 sq. ft in presence of factory-authorized representative.
 2. Shim or otherwise plumb substrates receiving metal wall panels.
 3. Flash and seal metal wall panels at perimeter of all openings. Fasten with self-tapping screws. Do not begin installation until weather barrier and flashings that will be concealed by metal wall panels are installed.
 4. Install screw fasteners in predrilled holes.
 5. Locate and space fastenings in uniform vertical and horizontal alignment.
 6. Install flashing and trim as metal wall panel work proceeds.
 7. Locate panel splices over, but not attached to, structural supports. Stagger panel splices and end laps to avoid a four-panel lap splice condition.
 8. Apply elastomeric sealant continuously between metal base channel (sill angle) and concrete and elsewhere as indicated or, if not indicated, as necessary for waterproofing.
 9. Align bottom of metal wall panels and fasten with blind rivets, bolts, or self-tapping screws. Fasten flashings and trim around openings and similar elements with self-tapping screws.
 10. Provide weathertight escutcheons for pipe and conduit penetrating exterior walls.
- B. Fasteners:
1. Aluminum Wall Panels: Use aluminum or stainless-steel fasteners for surfaces exposed to the exterior; use aluminum or galvanized steel fasteners for surfaces exposed to the interior.
- C. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action as recommended by metal wall panel manufacturer.
- D. Joint Sealers: Install gaskets, joint fillers, and sealants where indicated and where required for weathertight performance of metal wall panel assemblies. Provide types of gaskets, fillers, and sealants indicated or, if not indicated, types recommended by metal wall panel manufacturer.
1. Seal metal wall panel end laps with double beads of tape or sealant, full width of panel. Seal side joints where recommended by metal wall panel manufacturer.
 2. Prepare joints and apply sealants to comply with requirements in Section 07 92 00 "Joint Sealants."
- E. Lap-Seam Metal Wall Panels: Fasten metal wall panels to supports with fasteners at each lapped joint at location and spacing recommended by manufacturer.
1. Lap ribbed or fluted sheets one full rib corrugation. Apply panels and associated items for neat and weathertight enclosure. Avoid "panel creep" or application not true to line.
 2. Provide metal-backed washers under heads of exposed fasteners bearing on weather side of metal wall panels.
 3. Locate and space exposed fasteners in uniform vertical and horizontal alignment. Use proper tools to obtain controlled uniform compression for positive seal without rupture of washer.
 4. Install screw fasteners with power tools having controlled torque adjusted to compress washer tightly without damage to washer, screw threads, or panels.

- Install screws in predrilled holes.
5. Provide sealant tape at lapped joints of metal wall panels and between panels and protruding equipment, vents, and accessories.
 6. Apply a continuous ribbon of sealant tape to weather-side surface of fastenings on end laps; on side laps of nesting-type panels; on side laps of corrugated nesting-type, ribbed, or fluted panels; and elsewhere as needed to make panels weathertight.
 7. At panel splices, nest panels with minimum 6-inch end lap, sealed with butyl-rubber sealant and fastened together by interlocking clamping plates.
- F. Zee Clips: Provide Zee clips of size indicated or, if not indicated, as required to act as standoff from subgirts for thickness of insulation indicated. Attach to subgirts with fasteners.

3.04 ACCESSORY INSTALLATION

- A. General: Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.
1. Install components required for a complete metal wall panel assembly including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items.
- B. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.
1. Install exposed flashing and trim that is without excessive oil canning, buckling, and tool marks and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and to result in waterproof and weather-resistant performance.
 2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet with no joints allowed within 24 inches of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently weather resistant and waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with mastic sealant (concealed within joints).

3.05 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Water-Spray Test: After completing the installation of 75-foot- by-2-story minimum area of metal wall panel assembly, test assembly for water penetration according to AAMA 501.2 in a 2-bay area directed by Architect.
- C. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect and test completed metal wall panel installation, including accessories.
- D. Remove and replace metal wall panels where tests and inspections indicate that they do not comply with specified requirements.
- E. Additional tests and inspections, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.06 CLEANING AND PROTECTION

- A. Remove temporary protective coverings and strippable films, if any, as metal wall panels are installed, unless otherwise indicated in manufacturer's written installation instructions. On completion of metal wall panel installation, clean finished surfaces as recommended by metal wall panel manufacturer. Maintain in a clean condition during construction.
- B. After metal wall panel installation, clear weep holes and drainage channels of obstructions, dirt, and sealant.
- C. Replace metal wall panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 07 42 13

SECTION 07 42 16**INSULATED-CORE METAL WALL PANELS****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section Includes:
 - 1. Honeycomb-core metal wall panels.
- B. Related Sections:
 - 1. Section 05 40 00 "Cold-Formed Metal Framing" for cold-formed metal framing supporting metal wall panels.
 - 2. Section 07 42 13 "Concealed-Fastener Lap Seam Metal Wall Panels".

1.03 DEFINITIONS

- A. Metal Wall Panel Assembly: Insulated-core metal wall panels, attachment system components, miscellaneous metal framing, and accessories necessary for a complete weathertight wall system.

1.04 PERFORMANCE REQUIREMENTS

- A. General Performance: Metal wall panel assemblies shall comply with performance requirements without failure due to defective manufacture, fabrication, installation, or other defects in construction.
- B. Delegated Design: Design metal wall panel assembly, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- C. Air Infiltration: Air leakage through assembly of not more than 0.06 cfm/sq. ft. of wall area when tested according to ASTM E 283 at the following test-pressure difference:
 - 1. Test-Pressure Difference: 1.57 lbf/sq. ft. .
- D. Water Penetration under Static Pressure: No water penetration when tested according to ASTM E 331 at the following test-pressure difference:
 - 1. Test-Pressure Difference: 6.24 lbf/sq. ft.
- E. Structural Performance: Metal wall panel assemblies shall withstand the effects the following loads and stresses within limits and under conditions indicated, based on testing according to ASTM E 330:
 - 1. Wind Loads: Determine loads based on the following minimum design wind pressures:
 - a. Uniform pressure as indicated on Drawings.

2. Deflection Limits: Metal wall panel assemblies shall withstand wind loads with horizontal deflections no greater than $l/180$ $l/240$ \leq Insert deflection \geq of the span.
- F. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
 1. Temperature Change (Range): 120 deg F , ambient; 180 deg F, material surfaces.
- G. Thermal Performance: Provide insulated metal wall panel assemblies with thermal-resistance value (R-value) indicated when tested according to ASTM C 518.

1.05 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of wall panel and accessory.
- B. Shop Drawings: Show fabrication and installation layouts of metal wall panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details. Distinguish between factory-, shop- and field-assembled work.
 1. Accessories: Include details of the following items, at a scale of not less than 1-1/2 inches per 12 inches:
 - a. Flashing and trim.
 - b. Anchorage systems.
- C. Samples for Initial Selection: For each type of metal wall panel indicated with factory-applied color finishes.
 1. Include similar Samples of trim and accessories involving color selection.
- D. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below.
 1. Metal Wall and Soffit Panels: 12 inches long by actual panel width. Include fasteners, closures, and other metal wall panel accessories.
 2. Trim and Closures: 12 inches long. Include fasteners and other exposed accessories.
 3. Accessories: 12-inch-long Samples for each type of accessory.
- E. Delegated-Design Submittal: For metal wall panel assembly indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.06 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Exterior elevations drawn to scale and coordinating penetrations and wall-mounted items. Show the following:
 1. Wall panels and attachments.

2. Stud framing.
3. Wall-mounted items including doors, windows, louvers, and lighting fixtures.
4. Penetrations of wall by pipes and utilities.

B. Qualification Data: For professional engineer.

C. Material Certificates: For thermal insulation, signed by manufacturers.

D. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each product.

E. Field quality-control reports.

F. Warranties: Sample of special warranties.

1.07 CLOSEOUT SUBMITTALS

A. Maintenance Data: For metal wall panels to include in maintenance manuals.

1.08 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.

B. Source Limitations: Obtain each type of metal wall panel from single source from single manufacturer.

C. Fire-Resistance Ratings: Where indicated, provide metal wall panels identical to those of assemblies tested for fire resistance per ASTM E 119 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

D. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.

1. Build mockup of typical wall and corner panel, including soffit, as shown on Drawings; approximately one bay wide by one story high by full thickness, including insulation, supports, attachments, and accessories.
2. Conduct water spray test of mockup of metal wall panel assembly, testing for water penetration according to AAMA 501.2.
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
4. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

E. Preinstallation Conference: Conduct conference at Project site.

1. Meet with Owner, Architect, Owner's insurer if applicable, testing and inspecting agency representative, metal wall panel Installer, metal wall panel manufacturer's representative, structural-support Installer, and installers whose work interfaces with or affects metal wall panels, including installers of doors, windows, and louvers.
2. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and

avoid delays.

3. Review methods and procedures related to metal wall panel installation, including manufacturer's written instructions.
4. Examine support conditions for compliance with requirements, including alignment between and attachment to structural members.
5. Review flashings, special siding details, wall penetrations, openings, and condition of other construction that will affect metal wall panels.
6. Review governing regulations and requirements for insurance, certificates, and tests and inspections if applicable.
7. Review temporary protection requirements for metal wall panel assembly during and after installation.
8. Review wall panel observation and repair procedures after metal wall panel installation.

1.09 DELIVERY, STORAGE, AND HANDLING

- A. Deliver components, sheets, metal wall panels, and other manufactured items so as not to be damaged or deformed. Package metal wall panels for protection during transportation and handling.
- B. Unload, store, and erect metal wall panels in a manner to prevent bending, warping, twisting, and surface damage.
- C. Stack metal wall panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal wall panels to ensure dryness, with positive slope for drainage of water. Do not store metal wall panels in contact with other materials that might cause staining, denting, or other surface damage.
- D. Retain strippable protective covering on metal wall panel for period of metal wall panel installation.
- E. Protect foam-plastic insulation as follows:
 1. Do not expose to sunlight, except to extent necessary for period of installation and concealment.
 2. Protect against ignition at all times. Do not deliver foam-plastic insulation materials to Project site before installation time.
 3. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

1.10 PROJECT CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of metal wall panels to be performed according to manufacturers' written instructions and warranty requirements.
- B. Field Measurements: Verify locations of structural members and wall opening dimensions by field measurements before metal wall panel fabrication, and indicate measurements on Shop Drawings.

1.11 COORDINATION

- B. Coordinate metal wall panel assemblies with rain drainage work, flashing, trim, and construction of girts, studs, soffits, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.12 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal wall panel assemblies that fail in materials or workmanship within specified warranty period.
1. Failures include, but are not limited to, the following:
 - a. Structural failures including rupturing, cracking, or puncturing.
 - b. Deterioration of metals and other materials beyond normal weathering.
 2. Warranty Period: [Two] [Insert number] years from date of Substantial Completion.
- B. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal wall panels that show evidence of deterioration of factory-applied finishes within specified warranty period.
1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
 - b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
 2. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 PANEL MATERIALS

- A. Aluminum Sheet: Coil-coated sheet, ASTM B 209 , alloy as standard with manufacturer, with temper as required to suit forming operations and structural performance required.
1. Surface: Smooth, flat finish.
 2. Exposed Coil-Coated Finishes:
 - a. Three-Coat Fluoropolymer: AAMA 620. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 3. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil .
- B. Panel Sealants:
1. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch wide and 1/8 inch thick.
 2. Joint Sealant: ASTM C 920; elastomeric polyurethane, polysulfide, or silicone sealant; of type, grade, class, and use classifications required to seal joints in metal wall panels and remain weathertight; and as recommended in writing by metal wall panel manufacturer.
 3. Butyl-Rubber-Based, Solvent-Release Sealant: ASTM C 1311.

2.02 MISCELLANEOUS METAL FRAMING

- A. Miscellaneous Metal Framing, General: ASTM C 645, cold-formed metallic-coated steel sheet, ASTM A 653/A 653M, G40 hot-dip galvanized, or coating with equivalent corrosion resistance unless otherwise indicated.
- B. Subgirts: Manufacturer's standard C- or Z-shaped sections, 0.064-inch nominal thickness.
- C. Zee Clips: 0.079-inch nominal thickness.
- D. Base or Sill Angles: 0.079-inch nominal thickness.
- E. Hat-Shaped, Rigid Furring Channels:
 - 1. Nominal Thickness: As required to meet performance requirements.
 - 2. Depth: As indicated.
- F. Cold-Rolled Furring Channels: Minimum 1/2-inch- wide flange.
 - 1. Nominal Thickness: As required to meet performance requirements.
 - 2. Depth: As indicated.
 - 3. Furring Brackets: Adjustable, corrugated-edge type of steel sheet with 0.040-inch nominal thickness.
 - 4. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.062-inch-diameter wire, or double strand of 0.048-inch- diameter wire.
- G. Fasteners for Miscellaneous Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten miscellaneous metal framing members to substrates.

2.03 MISCELLANEOUS MATERIALS

- A. Panel Fasteners: Self-tapping screws; bolts and nuts; self-locking rivets and bolts; end-welded studs; and other suitable fasteners designed to withstand design loads. Provide exposed fasteners with heads matching color of metal wall panels by means of plastic caps or factory-applied coating. Provide EPDM, PVC, or neoprene sealing washers.

2.04 HONEYCOMB-CORE METAL WALL PANELS

- A. General: Provide factory-formed and -assembled metal wall panels fabricated from two metal facing sheets and honeycomb-core material laminated or otherwise securely bonded to facing sheets during fabrication without use of contact adhesives or pinch rollers, and with joints between panels designed to form weathertight seals. Include accessories required for weathertight installation.
 - 1. Panel Performance:
 - a. Fatigue: No evidence of delamination, core cracking, or permanent bowing when tested to a 20-lbf/sq. ft. positive and negative wind load and with deflection of L/180 for 2 million cycles.
 - b. Autoclave: No delamination when exposed to 2-psi pressure at a temperature of 212 deg F for 2-1/2 hours.
- B. Wrapped-Edge, Honeycomb-Core Metal Wall Panels: Formed with flush exterior panel facing wrapped over panel edges; designed for independent installation by mechanically attaching panels to supports using staggered, concealed side clips engaging panel edges; with sealant joints.

1. Basis of Design: Subject to requirements, provide QuadroClad 100 by Hunter Douglas.
2. Facings: Fabricate panel with exterior and interior facings of same material and thickness.
 - a. Material: Aluminum sheet, manufacturer's standard thickness.
 - b. Exterior Facing Finish: 3-coat fluoropolymer.
 - 1) Color: Traffic Red 3020.
 - c. Interior Facing Finish: Manufacturer's standard primer or polyester.
3. Aluminum Honeycomb Core: Manufacturer's standard 0.003-inch-thick, commercial grade aluminum with maximum 3/4-inch cell size.
4. Clips: Manufacturer's standard one piece, formed from stainless steel.
5. Gaskets: Extruded, dry seal silicone.
6. Sealant: Manufacturer's standard silicone.
7. Panel Thickness: 1.0 inch

2.05 ACCESSORIES

- A. Wall Panel Accessories: Provide components required for a complete metal wall panel assembly including trim, copings, fasciae, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal wall panels unless otherwise indicated.
 1. Closures: Provide closures at eaves and rakes, fabricated of same metal as metal wall panels.
 2. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
 3. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch- thick, flexible closure strips; cut or premolded to match metal wall panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.
- B. Flashing and Trim: Formed from 0.018-inch-minimum thickness, zinc-coated (galvanized) steel sheet or aluminum-zinc alloy-coated steel sheet prepainted with coil coating. Provide flashing and trim as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, bases, drips, sills, jambs, corners, endwalls, framed openings, rakes, fasciae, parapet caps, soffits, reveals, and fillers. Finish flashing and trim with same finish system as adjacent metal wall panels.

2.06 FABRICATION

- A. General: Fabricate and finish metal wall panels and accessories at the factory to greatest extent possible, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.
- B. Fabricate metal wall panels in a manner that eliminates condensation on interior side of panel and with joints between panels designed to form weathertight seals.
- C. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.

- D. Fabricate metal wall panel joints with factory-installed captive gaskets or separator strips that provide a tight seal and prevent metal-to-metal contact, in a manner that will minimize noise from movements within panel assembly.
- E. Honeycomb-Core Metal Wall Panels: Fabricate panels using manufacturer's standard thermosetting structural adhesive in a lamination process that bonds panel under minimum 10-psi pressure. Use of contact adhesives with pinch-roll process is not acceptable.
 - 1. Panel Bow Tolerance: Not more than 0.5 percent of panel width or length.
- F. Sheet Metal Accessories: Fabricate flashing and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to the design, dimensions, metal, and other characteristics of item indicated.
 - 1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
 - 2. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.
 - 3. Seams for Other Than Aluminum: Fabricate nonmoving seams in accessories with flat-lock seams. Tin edges to be seamed, form seams, and solder.
 - 4. Sealed Joints: Form nonexpansion but movable joints in metal to accommodate elastomeric sealant to comply with SMACNA standards.
 - 5. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.
 - 6. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended by metal wall panel manufacturer.
 - a. Size: As recommended by SMACNA's "Architectural Sheet Metal Manual" or metal wall panel manufacturer for application but not less than thickness of metal being secured.

2.07 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal wall panel supports, and other conditions affecting performance of work.
 - 1. Examine wall framing to verify that girts, angles, channels, studs, and other

- structural panel support members and anchorage have been installed within alignment tolerances required by metal wall panel manufacturer.
2. Examine wall sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required by metal wall panel manufacturer.
 3. Verify that weather-resistant sheathing paper has been installed over sheathing or backing substrate to prevent air infiltration or water penetration.
 4. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of work.
- B. Examine roughing-in for components and systems penetrating metal wall panels to verify actual locations of penetrations relative to seam locations of metal wall panels before metal wall panel installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Miscellaneous Framing: Install subgirts, base angles, sills, furring, and other miscellaneous wall panel support members and anchorages according to ASTM C 754 and metal wall panel manufacturer's written recommendations.

3.03 METAL WALL PANEL INSTALLATION, GENERAL

- A. General: Install metal wall panels according to manufacturer's written instructions in orientation, sizes, and locations indicated on Drawings. Install panels perpendicular to girts and subgirts unless otherwise indicated. Anchor metal wall panels and other components of the Work securely in place, with provisions for thermal and structural movement.
1. Commence metal wall panel installation and install minimum of 300 sq. ft. in presence of factory-authorized representative.
 2. Shim or otherwise plumb substrates receiving metal wall panels.
 3. Flash and seal metal wall panels with weather closures at perimeter of all openings. Fasten with self-tapping screws. Do not begin installation until weather barrier and flashings that will be concealed by metal wall panels are installed.
 4. Install screw fasteners in predrilled holes.
 5. Locate and space fastenings in uniform vertical and horizontal alignment.
 6. Install flashing and trim as metal wall panel work proceeds.
 7. Locate panel splices over, but not attached to, structural supports. Stagger panel splices and end laps to avoid a four-panel lap splice condition.
 8. Apply elastomeric sealant continuously between metal base channel (sill angle) and concrete, and elsewhere as indicated or, if not indicated, as necessary for waterproofing.
 9. Align bottom of metal wall panels and fasten with blind rivets, bolts, or self-tapping screws. Fasten flashings and trim around openings and similar elements with self-tapping screws.
 10. Provide weathertight escutcheons for pipe and conduit penetrating exterior walls.
- B. Fasteners:
1. Steel Wall Panels: Use stainless-steel fasteners for surfaces exposed to the exterior; use galvanized steel fasteners for surfaces exposed to the interior.
 2. Aluminum Wall Panels: Use aluminum or stainless-steel fasteners for surfaces exposed to the exterior; use aluminum or galvanized steel fasteners for surfaces exposed to the interior.
 3. Copper Wall Panels: Use copper, stainless-steel, or hardware-bronze fasteners.

4. Stainless-Steel Wall Panels: Use stainless-steel fasteners.
- C. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action as recommended by metal wall panel manufacturer.
- D. Joint Sealers: Install gaskets, joint fillers, and sealants where indicated and where required for weathertight performance of metal wall panel assemblies. Provide types of gaskets, fillers, and sealants indicated or, if not indicated, types recommended by metal wall panel manufacturer.
 1. Seal metal wall panel end laps with double beads of tape or sealant, full width of panel. Seal side joints where recommended by metal wall panel manufacturer.
 2. Prepare joints and apply sealants to comply with requirements in Division 07 Section "Joint Sealants."

3.04 INSULATED-CORE METAL WALL PANEL INSTALLATION

- A. General: Apply continuous ribbon of sealant to panel joint on concealed side of insulated-core metal wall panels as vapor seal; apply sealant to panel joint on exposed side of panels for weather seal.
 1. Fasten insulated-core metal wall panels to supports with fasteners at each lapped joint at location and spacing and with fasteners recommended by manufacturer.
 2. Lap ribbed or fluted sheets one full rib corrugation. Apply panels and associated items for neat and weathertight enclosure. Avoid "panel creep" or application not true to line.
 3. Provide metal-backed washers under heads of exposed fasteners on weather side of insulated metal wall panels.
 4. Locate and space exposed fasteners in uniform vertical and horizontal alignment. Use proper tools to obtain controlled uniform compression for positive seal without rupture of washer.
 5. Provide sealant tape at lapped joints of insulated metal wall panels and between panels and protruding equipment, vents, and accessories.
 6. Apply a continuous ribbon of sealant tape to panel side laps and elsewhere as needed to make panels weathertight.
 7. Apply snap-on battens to exposed-fastener, insulated-core metal wall panel seams to conceal fasteners.
- B. Honeycomb-Core Metal Wall Panels:
 1. Wrapped-Edge Panels: Mechanically attach wall panels to supports using staggered, concealed side clips engaging wrapped panel edges. Install clips to supports with self-tapping fasteners. Seal joints with [backer rod and sealant] [manufacturer's standard gaskets].
 2. Wrapped-Edge Panels: Mechanically attach wall panels through extended edge of panels to supports using self-tapping fasteners. Seal joints with [backer rod and sealant] [manufacturer's standard gaskets].
 3. Shiplap-Edge Panels: Mechanically attach wall panels to supports using staggered, concealed side clips engaging tongue-and-groove panel edges. Install clips to supports with self-tapping fasteners.
 - a. Horizontal Joints: [Maintain reveal joint of consistent width] [Seal joints with backer rod and sealant] [Seal joints with manufacturer's standard gaskets].
 - b. Vertical Joints: [Maintain reveal joint of consistent width] [Seal joints with backer rod and sealant] [Seal joints with manufacturer's standard gaskets].

4. Framed-Edge Panels: Mechanically attach wall panels through integral, extruded edge members to supports using self-tapping fasteners. Seal joints with manufacturer's standard gaskets.

3.05 ACCESSORY INSTALLATION

- A. General: Install accessories with positive anchorage to building and weathertight mounting and provide for thermal expansion. Coordinate installation with flashings and other components.
 1. Install components required for a complete metal wall panel assembly including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items.
- B. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.
 1. Install exposed flashing and trim that is without excessive oil canning, buckling, and tool marks and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and to result in waterproof and weather-resistant performance.
 2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet with no joints allowed within 24 inches of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently weather resistant and waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with mastic sealant (concealed within joints).

3.06 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Water-Spray Test: After completing the installation of 75-foot- by-2-story minimum area of metal wall panel assembly, test assembly for water penetration according to AAMA 501.2 in a 2-bay area directed by Architect.
- C. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect and test completed metal wall panel installation, including accessories.
- D. Remove and replace metal wall panels where tests and inspections indicate that they do not comply with specified requirements.
- E. Additional tests and inspections, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.07 CLEANING AND PROTECTION

- A. Remove temporary protective coverings and strippable films, if any, as metal wall panels are installed unless otherwise indicated in manufacturer's written installation instructions. On completion of metal wall panel installation, clean finished surfaces as recommended by metal wall panel manufacturer. Maintain in a clean condition during construction.
- B. After metal wall panel installation, clear weep holes and drainage channels of obstructions, dirt, and sealant.

- C. Replace metal wall panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 07 42 16

SECTION 07 54 23**THERMOPLASTIC POLYOLEFIN ROOFING****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY**A. Section Includes:**

1. Adhered thermoplastic polyolefin roofing system.
2. Vapor retarder.
3. Roof insulation.

- B. Section includes the installation of insulation strips in ribs of roof deck. Insulation strips are furnished under Section 05 31 00 "Steel Decking."

C. Related Requirements:

1. Section 07 21 16 "Blanket Insulation" for insulation beneath the roof deck.
2. Section 07 62 00 "Sheet Metal Flashing and Trim" for metal roof flashings and counterflashings.
3. Section 07 71 29 "Manufactured Roof Expansion Joints" for proprietary manufactured roof expansion-joint assemblies.
4. Section 07 92 00 "Joint Sealants" for joint sealants, joint fillers, and joint preparation.
5. Section 22 14 23 "Facility Storm Drainage Piping Specialties" for roof drains.

1.03 DEFINITIONS

- A. Roofing Terminology: Definitions in ASTM D 1079 and glossary in NRCA's "The NRCA Roofing and Waterproofing Manual" apply to work of this Section.

1.04 PREINSTALLATION MEETINGS**A. Preinstallation Roofing Conference: Conduct conference at Project site.**

1. Meet with Owner, Architect, Owner's insurer if applicable, testing and inspecting agency representative, roofing Installer, roofing system manufacturer's representative, deck Installer, and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
2. Review methods and procedures related to roofing installation, including manufacturer's written instructions.
3. Review and finalize construction schedule, and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
4. Examine deck substrate conditions and finishes for compliance with requirements, including flatness and fastening.
5. Review structural loading limitations of roof deck during and after roofing.
6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that affects roofing system.
7. Review governing regulations and requirements for insurance and certificates if applicable.

8. Review temporary protection requirements for roofing system during and after installation.
9. Review roof observation and repair procedures after roofing installation.

1.05 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. LEED Submittals:
 1. Product Data for Credit SS 7.2: For roof materials, documentation indicating that roof materials comply with Solar Reflectance Index requirement.
 2. Product Data for Credit IEQ 4.1: For adhesives and sealants used inside the weatherproofing system, documentation including printed statement of VOC content.
- C. Shop Drawings: For roofing system. Include plans, elevations, sections, details, and attachments to other work, including:
 1. Base flashings and membrane terminations.
 2. Tapered insulation, including slopes.
 3. Roof plan showing orientation of steel roof deck and orientation of roofing, fastening spacings, and patterns for mechanically fastened roofing.
 4. Insulation fastening patterns for corner, perimeter, and field-of-roof locations.
- D. Samples for Verification: For the following products:
 1. Sheet roofing, of color required.
 2. Walkway pads or rolls, of color required.

1.06 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer and manufacturer.
- B. Manufacturer Certificates: Signed by roofing manufacturer certifying that roofing system complies with requirements specified in "Performance Requirements" Article.
 1. Submit evidence of compliance with performance requirements.
- C. Product Test Reports: For components of roofing system, tests performed by manufacturer and witnessed by a qualified testing agency.
- D. Research/Evaluation Reports: For components of roofing system, from ICC-ES.
- E. Field quality-control reports.
- F. Sample Warranties: For manufacturer's special warranties.

1.07 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For roofing system to include in maintenance manuals.

1.08 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A qualified manufacturer that is UL listed for roofing system identical to that used for this Project.
- B. Installer Qualifications: A qualified firm that is approved by roofing system

manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.

1.09 DELIVERY, STORAGE, AND HANDLING

- A. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.
- B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer. Protect stored liquid material from direct sunlight.
 - 1. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.
- C. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.
- D. Handle and store roofing materials, and place equipment in a manner to avoid permanent deflection of deck.

1.10 FIELD CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to manufacturer's written instructions and warranty requirements.

1.11 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of roofing system that fail in materials or workmanship within specified warranty period.
 - 1. Special warranty includes roofing, base flashings, roof insulation, cover boards, substrate board, and other components of roofing system.
 - 2. Warranty Period: 15 years from date of Substantial Completion.
- B. Special Project Warranty: Submit roofing Installer's warranty, on warranty form at end of this Section, signed by Installer, covering the Work of this Section, including all components of roofing system such as roofing, base flashing, roof insulation, fasteners, cover boards, substrate boards, vapor retarders, roof pavers, and walkway products, for the following warranty period:
 - 1. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Sure-Weld Adhered Roofing System by Carlisle Syntec Systems or comparable product by one of the following:
 - 1. Firestone Building Products.

2. GAF Materials Corporation.
3. GenFlex Roofing Systems.
4. Johns Manville.
5. Mule-Hide Products Co., Inc.

- B. Source Limitations: Obtain components including roof insulation for roofing system from same manufacturer as membrane roofing or manufacturer approved by membrane roofing manufacturer.

2.02 PERFORMANCE REQUIREMENTS

- A. General Performance: Installed roofing and base flashings shall withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Roofing and base flashings shall remain watertight.
1. Accelerated Weathering: Roofing system shall withstand 2000 hours of exposure when tested according to ASTM G 152, ASTM G 154, or ASTM G 155.
 2. Impact Resistance: Roofing system shall resist impact damage when tested according to ASTM D 3746 or ASTM D 4272.
- B. Material Compatibility: Roofing materials shall be compatible with one another and adjacent materials under conditions of service and application required, as demonstrated by roofing manufacturer based on testing and field experience.
- C. Roofing System Design: Tested by a qualified testing agency to resist the following uplift pressures:
1. Corner Uplift Pressure: <Insert lbf/sq. ft.>.
 2. Perimeter Uplift Pressure: <Insert lbf/sq. ft.>.
 3. Field-of-Roof Uplift Pressure: <Insert lbf/sq. ft.>.
- D. FM Global Listing: Roofing, base flashings, and component materials shall comply with requirements in FM Global 4450 or FM Global 4470 as part of a built-up roofing system, and shall be listed in FM Global's "RoofNav" for Class 1 or noncombustible construction, as applicable. Identify materials with FM Global markings.
1. Fire/Windstorm Classification: [Class 1A-60] [Class 1A-75] [Class 1A-90] [Class 1A-105] [Class 1A-120] <Insert class>.
 2. Hail-Resistance Rating: [MH] [SH].
- E. Solar Reflectance Index: Not less than 78 when calculated according to ASTM E 1980, based on testing identical products by a qualified testing agency.
- F. Exterior Fire-Test Exposure: ASTM E 108 or UL 790, Class A; for application and roof slopes indicated; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

2.03 TPO ROOFING

- A. Fabric-Reinforced TPO Sheet: ASTM D 6878, internally fabric- or scrim-reinforced, uniform, flexible fabric-backed TPO sheet.
1. Thickness: 60 mils, nominal.
 2. Exposed Face Color: White.

2.04 AUXILIARY ROOFING MATERIALS

- A. General: Auxiliary materials recommended by roofing system manufacturer for intended use and compatible with roofing.
 - 1. Liquid-type auxiliary materials shall comply with VOC limits of authorities having jurisdiction.
 - 2. Adhesives and sealants that are not on the exterior side of weather barrier shall comply with the following limits for VOC content:
 - a. Plastic Foam Adhesives: 50 g/L.
 - b. Gypsum Board and Panel Adhesives: 50 g/L.
 - c. Multipurpose Construction Adhesives: 70 g/L.
 - d. Fiberglass Adhesives: 80 g/L.
 - e. Single-Ply Roof Membrane Adhesives: 250 g/L.
 - f. Single-Ply Roof Membrane Sealants: 450 g/L.
 - g. Nonmembrane Roof Sealants: 300 g/L.
 - h. Sealant Primers for Nonporous Substrates: 250 g/L.
 - i. Sealant Primers for Porous Substrates: 775 g/L.
 - j. Other Adhesives and Sealants: 250 g/L.
- B. Sheet Flashing: Manufacturer's standard unreinforced TPO sheet flashing, 55 mils thick, minimum, of same color as TPO sheet.
- C. Bonding Adhesive: Manufacturer's standard, water based.
- D. Slip Sheet: Manufacturer's standard, of thickness required for application.
- E. Metal Termination Bars: Manufacturer's standard, predrilled stainless-steel or aluminum bars, approximately 1 by 1/8 inch thick; with anchors.
- F. Metal Battens: Manufacturer's standard, aluminum-zinc-alloy-coated or zinc-coated steel sheet, approximately 1 inch wide by 0.05 inch thick, prepunched.
- G. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Global 4470, designed for fastening roofing to substrate, and acceptable to roofing system manufacturer.
- H. Miscellaneous Accessories: Provide pourable sealers, preformed cone and vent sheet flashings, preformed inside and outside corner sheet flashings, T-joint covers, lap sealants, termination reglets, and other accessories.

2.05 SUBSTRATE BOARDS

- A. Substrate Board: ASTM C 1177/C 1177M, glass-mat, water-resistant gypsum substrate, 1/2 inch thick.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. CertainTeed Corporation; GlasRoc Sheathing Type X.
 - b. Georgia-Pacific Corporation; Dens Deck Prime.
 - c. National Gypsum Company; Gold Bond eXP Extended Exposure Sheathing.
 - d. USG Corporation; Securock Glass Mat Roof Board.
- B. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Global 4470, designed for fastening substrate board to roof deck.

2.06 VAPOR RETARDER

- A. Polyethylene Film: ASTM D 4397, 6 mils thick, minimum, with maximum permeance rating of 0.13 perm.
 1. Tape: Pressure-sensitive tape of type recommended by vapor-retarder manufacturer for sealing joints and penetrations in vapor retarder.
 2. Adhesive: Manufacturer's standard lap adhesive.
- B. Laminated Sheet: Polyethylene laminate, two layers, reinforced with cord grid, with maximum permeance rating of 0.06 perm.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Reef Industries, Inc.
 2. Tape: Pressure-sensitive tape of type recommended by vapor-retarder manufacturer for sealing joints and penetrations in vapor retarder.

2.07 ROOF INSULATION

- A. General: Preformed roof insulation boards manufactured or approved by TPO roofing manufacturer, selected from manufacturer's standard sizes suitable for application, of thicknesses indicated and that produce FM Global-approved roof insulation.
- B. Polyisocyanurate Board Insulation: ASTM C 1289, Type II, Class 1, Grade 2, felt or glass-fiber mat facer on both major surfaces.
 1. Basis-of-Design Product: Subject to compliance with requirements, provide HP-H Polyiso by Carlisle Syntec Systems or comparable product by one of the following:
 - a. Atlas Roofing Corporation.
 - b. Firestone Building Products.
 - c. GAF Materials Corporation.
 - d. Hunter Panels.
 - e. Insulfoam LLC; a Carlisle company.
 - f. Johns Manville.
 - g. Rmax, Inc.
- C. Tapered Insulation: Provide factory-tapered insulation boards fabricated to slope of 1/4 inch per 12 inches unless otherwise indicated.

2.08 INSULATION ACCESSORIES

- A. General: Roof insulation accessories recommended by insulation manufacturer for intended use and compatibility with roofing.
- B. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Global 4470, designed for fastening roof insulation and cover boards to substrate, and acceptable to roofing system manufacturer.
- C. Insulation Adhesive: Insulation manufacturer's recommended adhesive formulated to attach roof insulation to substrate or to another insulation layer as follows:
 1. Modified asphaltic, asbestos-free, cold-applied adhesive.

- D. Cover Board: ASTM C 208, Type II, Grade 2, cellulosic-fiber insulation board, 1/2 inch thick.
- E. Cover Board: ASTM C 1177/C 1177M, glass-mat, water-resistant gypsum substrate, 1/4 inch thick, factory primed.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. CertainTeed Corporation; GlasRoc Sheathing Type X.
 - b. Georgia-Pacific Corporation; Dens Deck Prime.
 - c. National Gypsum Company; Gold Bond eXP Extended Exposure Sheathing.
 - d. USG Corporation; Securock Glass Mat Roof Board.
- F. Protection Mat: Woven or nonwoven polypropylene, polyolefin, or polyester fabric, water permeable and resistant to UV degradation, type and weight as recommended by roofing system manufacturer for application.

2.09 ASPHALT MATERIALS

- A. Roofing Asphalt: ASTM D 312, Type III or Type IV.

2.10 WALKWAYS

- A. Flexible Walkways: Factory-formed, nonporous, heavy-duty, slip-resisting, surface-textured walkway pads or rolls, approximately 3/16 inch thick and acceptable to roofing system manufacturer.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work:
1. Verify that roof openings and penetrations are in place, curbs are set and braced, and roof-drain bodies are securely clamped in place.
 2. Verify that wood blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.
 3. Verify that surface plane flatness and fastening of steel roof deck complies with requirements in Section 05 31 00 "Steel Decking."
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing installation according to roofing system manufacturer's written instructions. Remove sharp projections.
- B. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.
- C. Install insulation strips according to acoustical roof deck manufacturer's written instructions.

3.03 ROOFING INSTALLATION, GENERAL

- A. Install roofing system according to roofing system manufacturer's written instructions.
- B. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system at the end of the workday or when rain is forecast. Remove and discard temporary seals before beginning work on adjoining roofing.
- C. Install roofing and auxiliary materials to tie in to existing roofing to maintain weathertightness of transition.

3.04 SUBSTRATE BOARD INSTALLATION

- A. Install substrate board with long joints in continuous straight lines, perpendicular to roof slopes with end joints staggered between rows. Tightly butt substrate boards together.
 - 1. Fasten substrate board to top flanges of steel deck according to recommendations in FM Global's "RoofNav" and FM Global Loss Prevention Data Sheet 1-29 for specified Windstorm Resistance Classification.
 - 2. Fasten substrate board to top flanges of steel deck to resist uplift pressure at corners, perimeter, and field of roof according to roofing system manufacturers' written instructions.

3.05 VAPOR-RETARDER INSTALLATION

- A. Polyethylene Film: Loosely lay polyethylene-film vapor retarder in a single layer over area to receive vapor retarder, side and end lapping each sheet a minimum of 2 inches and 6 inches, respectively. Continuously seal side and end laps with [tape] [adhesive].
- B. Laminate Sheet: Loosely lay laminate-sheet vapor retarder in a single layer over area to receive vapor retarder, side and end lapping each sheet a minimum of 2 inches and 6 inches, respectively. Continuously seal side and end laps with tape.
- C. Self-Adhering-Sheet Vapor Retarder: Prime substrate if required by manufacturer. Install self-adhering-sheet vapor retarder over area to receive vapor retarder, side and end lapping each sheet a minimum of 3-1/2 inches and 6 inches, respectively. Seal laps by rolling.
- D. Completely seal vapor retarder at terminations, obstructions, and penetrations to prevent air movement into roofing system.

3.06 INSULATION INSTALLATION

- A. Coordinate installing roofing system components so insulation is not exposed to precipitation or left exposed at the end of the workday.
- B. Comply with roofing system and insulation manufacturer's written instructions for installing roof insulation.
- C. Install tapered insulation under area of roofing to conform to slopes indicated.
- D. Install insulation under area of roofing to achieve required thickness. Where overall insulation thickness is 2.7 inches or greater, install two or more layers with joints of each succeeding layer staggered from joints of previous layer a minimum of 6 inches in each direction.

- E. Trim surface of insulation where necessary at roof drains so completed surface is flush and does not restrict flow of water.
- F. Install insulation with long joints of insulation in a continuous straight line with end joints staggered between rows, abutting edges and ends between boards. Fill gaps exceeding 1/4 inch with insulation.
 - 1. Cut and fit insulation within 1/4 inch of nailers, projections, and penetrations.
- G. Mechanically Fastened Insulation: Install each layer of insulation and secure to deck using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to deck type.
 - 1. Fasten insulation according to requirements in FM Global's "RoofNav" for specified Windstorm Resistance Classification.
 - 2. Fasten insulation to resist uplift pressure at corners, perimeter, and field of roof.
- H. Mechanically Fastened and Adhered Insulation: Install each layer of insulation to deck using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to deck type.
 - 1. Fasten first layer of insulation to resist uplift pressure at corners, perimeter, and field of roof.
 - 2. Set each subsequent layer of insulation in a solid mopping of hot roofing asphalt, applied within plus or minus 25 deg F of equiviscous temperature.
 - 3. Set each subsequent layer of insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.
 - 4. Set each subsequent layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.
- I. Install cover boards over insulation with long joints in continuous straight lines with end joints staggered between rows. Offset joints of insulation below a minimum of 6 inches in each direction. Loosely butt cover boards together and fasten to roof deck.
 - 1. Fasten cover boards to resist uplift pressure at corners, perimeter, and field of roof.

3.07 ADHERED ROOFING INSTALLATION

- A. Adhere roofing over area to receive roofing according to roofing system manufacturer's written instructions. Unroll roofing and allow to relax before retaining.
- B. Start installation of roofing in presence of roofing system manufacturer's technical personnel.
- C. Accurately align roofing, and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.
- D. Bonding Adhesive: Apply to substrate and underside of roofing at rate required by manufacturer, and allow to partially dry before installing roofing. Do not apply to splice area of roofing.
- E. In addition to adhering, mechanically fasten roofing securely at terminations, penetrations, and perimeter of roofing.
- F. Apply roofing with side laps shingled with slope of roof deck where possible.

- G. Seams: Clean seam areas, overlap roofing, and hot-air weld side and end laps of roofing and sheet flashings according to manufacturer's written instructions, to ensure a watertight seam installation.
 - 1. Test lap edges with probe to verify seam weld continuity. Apply lap sealant to seal cut edges of sheet.
 - 2. Verify field strength of seams a minimum of twice daily, and repair seam sample areas.
 - 3. Repair tears, voids, and lapped seams in roofing that do not comply with requirements.
- H. Spread sealant bed over deck-drain flange at roof drains, and securely seal roofing in place with clamping ring.

3.08 BASE FLASHING INSTALLATION

- A. Install sheet flashings and preformed flashing accessories, and adhere to substrates according to roofing system manufacturer's written instructions.
- B. Apply bonding adhesive to substrate and underside of sheet flashing at required rate, and allow to partially dry. Do not apply to seam area of flashing.
- C. Flash penetrations and field-formed inside and outside corners with cured or uncured sheet flashing.
- D. Clean seam areas, overlap, and firmly roll sheet flashings into the adhesive. Hot-air weld side and end laps to ensure a watertight seam installation.
- E. Terminate and seal top of sheet flashings and mechanically anchor to substrate through termination bars.

3.09 WALKWAY INSTALLATION

- A. Flexible Walkways: Install walkway products in locations indicated. Heat weld to substrate or adhere walkway products to substrate with compatible adhesive according to roofing system manufacturer's written instructions.

3.10 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to inspect substrate conditions, surface preparation, membrane application, flashings, protection, and drainage components, and to furnish reports to Architect.
- B. Flood Testing: Flood test each roofing area for leaks, according to recommendations in ASTM D 5957, after completing roofing and flashing but before overlying construction is placed. Install temporary containment assemblies, plug or dam drains, and flood with potable water.
 - 1. Flood to an average depth of 2-1/2 inches with a minimum depth of 1 inch and not exceeding a depth of 4 inches. Maintain 2 inches of clearance from top of base flashing.
 - 2. Flood each area for 24, 48, 72 hours.
 - 3. After flood testing, repair leaks, repeat flood tests, and make further repairs until roofing and flashing installations are watertight.
- C. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel

to inspect roofing installation on completion.

- D. Repair or remove and replace components of roofing system where inspections indicate that they do not comply with specified requirements.
- E. Additional testing and inspecting, at Contractor's expense, will be performed to determine if replaced or additional work complies with specified requirements.

3.11 PROTECTING AND CLEANING

- A. Protect roofing system from damage and wear during remainder of construction period. When remaining construction does not affect or endanger roofing, inspect roofing for deterioration and damage, describing its nature and extent in a written report, with copies to Architect and Owner.
- B. Correct deficiencies in or remove roofing system that does not comply with requirements, repair substrates, and repair or reinstall roofing system to a condition free of damage and deterioration at time of Substantial Completion and according to warranty requirements.
- C. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

3.12 ROOFING INSTALLER'S WARRANTY

(See next page for sample installer's warranty)

- A. WHEREAS _____ of _____, herein called the "Roofing Installer," has performed roofing and associated work ("work") on the following project:
1. Owner: <Insert name of Owner>.
 2. Address: <Insert address>.
 3. Building Name/Type: <Insert information>.
 4. Address: <Insert address>.
 5. Area of Work: <Insert information>.
 6. Acceptance Date: _____.
 7. Warranty Period: <Insert time>.
 8. Expiration Date: _____.
- B. AND WHEREAS Roofing Installer has contracted (either directly with Owner or indirectly as a subcontractor) to warrant said work against leaks and faulty or defective materials and workmanship for designated Warranty Period,
- C. NOW THEREFORE Roofing Installer hereby warrants, subject to terms and conditions herein set forth, that during Warranty Period he will, at his own cost and expense, make or cause to be made such repairs to or replacements of said work as are necessary to correct faulty and defective work and as are necessary to maintain said work in a watertight condition.
- D. This Warranty is made subject to the following terms and conditions:
1. Specifically excluded from this Warranty are damages to work and other parts of the building, and to building contents, caused by:
 - a. lightning;
 - b. peak gust wind speed exceeding <Insert mph>;
 - c. fire;
 - d. failure of roofing system substrate, including cracking, settlement, excessive deflection, deterioration, and decomposition;
 - e. faulty construction of parapet walls, copings, chimneys, skylights, vents, equipment supports, and other edge conditions and penetrations of the work;
 - f. vapor condensation on bottom of roofing; and
 - g. activity on roofing by others, including construction contractors, maintenance personnel, other persons, and animals, whether authorized or unauthorized by Owner.
 2. When work has been damaged by any of foregoing causes, Warranty shall be null and void until such damage has been repaired by Roofing Installer and until cost and expense thereof have been paid by Owner or by another responsible party so designated.
 3. Roofing Installer is responsible for damage to work covered by this Warranty but is not liable for consequential damages to building or building contents resulting from leaks or faults or defects of work.
 4. During Warranty Period, if Owner allows alteration of work by anyone other than Roofing Installer, including cutting, patching, and maintenance in connection with penetrations, attachment of other work, and positioning of anything on roof, this Warranty shall become null and void on date of said alterations, but only to the extent said alterations affect work covered by this Warranty. If Owner engages Roofing Installer to perform said alterations, Warranty shall not become null and void unless Roofing Installer, before starting said work, shall have notified Owner in writing, showing reasonable cause for claim, that said alterations would likely damage or deteriorate work, thereby reasonably justifying a limitation or termination of this Warranty.

5. During Warranty Period, if original use of roof is changed and it becomes used for, but was not originally specified for, a promenade, work deck, spray-cooled surface, flooded basin, or other use or service more severe than originally specified, this Warranty shall become null and void on date of said change, but only to the extent said change affects work covered by this Warranty.
6. Owner shall promptly notify Roofing Installer of observed, known, or suspected leaks, defects, or deterioration and shall afford reasonable opportunity for Roofing Installer to inspect work and to examine evidence of such leaks, defects, or deterioration.
7. This Warranty is recognized to be the only warranty of Roofing Installer on said work and shall not operate to restrict or cut off Owner from other remedies and resources lawfully available to Owner in cases of roofing failure. Specifically, this Warranty shall not operate to relieve Roofing Installer of responsibility for performance of original work according to requirements of the Contract Documents, regardless of whether Contract was a contract directly with Owner or a subcontract with Owner's General Contractor.

E. IN WITNESS THEREOF, this instrument has been duly executed this _____ day of _____, _____.

1. Authorized Signature: _____.
2. Name: _____.
3. Title: _____.

END OF SECTION 07 54 23

SECTION 07 62 00**SHEET METAL FLASHING AND TRIM****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. This Section includes the following sheet metal flashing and trim:
1. Formed equipment support flashing.
- B. Related Sections include the following:
1. Division 06 Section "Miscellaneous Rough Carpentry" for wood nailers, curbs and blocking.
 2. Division 07 Section "Manufactured Roof Expansion Joints" for expansion joints installed with roofing system.
 3. Division 07 Section "Roof Hatches."
 4. Division 07 Section "Joint Sealants" for field-applied sheet metal flashing and trim sealants.

1.03 DEFINITIONS

- A. Gauge numbers and corresponding metal thicknesses shall be as indicated in the table below.

Gauge	U.S. Standard Gauge for Uncoated Hot & Cold Rolled Sheets	Galvanized Sheet Gauge for Hot-Dipped Zinc Coated Sheets
20	0.0359	0.0396
21	0.0329	0.0366
22	0.0299	0.0336
23	0.0269	0.0306
24	0.0239	0.0276
25	0.0209	0.0247
26	0.0179	0.0217

1.04 SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each manufactured product and accessory.
- B. LEED Submittals:
1. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and

preconsumer recycled content. Include statement indicating cost for each product having recycled content.

- C. Shop Drawings: Show fabrication and installation layouts of sheet metal flashing and trim, including plans, elevations, expansion-joint locations, and keyed details. Distinguish between shop- and field-assembled work. Include the following:
1. Identification of material, thickness, weight, and finish for each item and location in Project.
 2. Details for forming sheet metal flashing and trim, including profiles, shapes, seams, and dimensions.
 3. Details for joining, supporting, and securing sheet metal flashing and trim, including layout of fasteners, cleats, clips, and other attachments. Include pattern of seams.
 4. Details of termination points and assemblies, including fixed points.
 5. Details of expansion joints and expansion-joint covers, including showing direction of expansion and contraction.
 6. Details of edge conditions, including eaves, ridges, valleys, rakes, crickets, and counterflashings as applicable.
 7. Details of special conditions.
 8. Details of connections to adjoining work.
- D. Samples for Initial Selection: For each type of sheet metal flashing, trim, and accessory indicated with factory-applied color finishes involving color selection.
- E. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below:
1. Sheet Metal Flashing: 12 inches long by actual width of unit, including finished seam and in required profile. Include fasteners, cleats, clips, closures, and other attachments.
 2. Trim, Metal Closures, Expansion Joints, Joint Intersections, and Miscellaneous Fabrications: 12 inches long and in required profile. Include fasteners and other exposed accessories.
 3. Accessories and Miscellaneous Materials: Full-size Sample.
 4. Anodized Aluminum Samples: Samples to show full range to be expected for each color required.
- F. Qualification Data: For qualified fabricator.
- G. Warranty: Sample of special warranty.
- H. Maintenance Data: For sheet metal flashing, trim, and accessories to include in maintenance manuals.

1.05 QUALITY ASSURANCE

- A. Sheet Metal Flashing and Trim Standard: Comply with SMACNA's "Architectural Sheet Metal Manual." Conform to dimensions and profiles shown unless more stringent requirements are indicated.
- B. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."
1. Meet with Authority, Architect, Authority's insurer if applicable, Installer, and installers whose work interfaces with or affects sheet metal flashing and trim

including installers of roofing materials, roof accessories, unit skylights, and roof-mounted equipment.

2. Review methods and procedures related to sheet metal flashing and trim.
3. Examine substrate conditions for compliance with requirements, including flatness and attachment to structural members.
4. Document proceedings, including corrective measures and actions required, and furnish copy of record to each participant.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver sheet metal flashing materials and fabrications undamaged. Protect sheet metal flashing and trim materials and fabrications during transportation and handling.
- B. Unload, store, and install sheet metal flashing materials and fabrications in a manner to prevent bending, warping, twisting, and surface damage.
- C. Stack materials on platforms or pallets, covered with suitable weathertight and ventilated covering. Do not store sheet metal flashing and trim materials in contact with other materials that might cause staining, denting, or other surface damage.

1.07 COORDINATION

- A. Coordinate installation of sheet metal flashing and trim with interfacing and adjoining construction to provide a leakproof, secure, and noncorrosive installation.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. General: Sheet metal flashing and trim assemblies shall withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Completed sheet metal flashing and trim shall not rattle, leak, or loosen, and shall remain watertight.
- B. Sheet Metal Standard for Flashing and Trim: Comply with NRCA's "The NRCA Roofing Manual" requirements for dimensions and profiles shown unless more stringent requirements are indicated.
- C. Recycled Content of Steel-Sheet Flashing and Trim: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
- D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes to prevent buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.02 SHEET METALS

- A. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, G90 coating designation; structural quality.
- B. Stainless-Steel Sheet: ASTM A 240/A 240M, Type 304 with No. 2D (dull, cold rolled) finish.

2.03 MISCELLANEOUS MATERIALS

- A. General: Provide materials and types of fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation.
- B. Fasteners: Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads.
 - 1. Fasteners for Flashing and Trim: Blind
 - 2. Blind Fasteners: High-strength aluminum or stainless-steel rivets.
- C. Elastomeric Sealant: ASTM C 920, elastomeric polymer sealant of composition indicated below; and of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.
 - 1. For Galvanized Metal and Stainless Steel: Polyurethane.
- D. Butyl Sealant: ASTM C 1311, single-component, solvent-release butyl rubber sealant, polyisobutylene plasticized, heavy bodied for hooked-type expansion joints with limited movement.
- E. Epoxy Seam Sealer: Two-part, noncorrosive, aluminum seam-cementing compound, recommended by aluminum manufacturer for exterior nonmoving joints, including riveted joints.
- F. Bituminous Coating: Cold-applied asphalt mastic, SSPC-Paint 12, compounded for 15-mil dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

2.04 FABRICATION, GENERAL

- A. General: Custom fabricate sheet metal flashing and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated. Shop fabricate items where practicable. Obtain field measurements for accurate fit before shop fabrication.
- B. Fabricate sheet metal flashing and trim in thickness or weight needed to comply with performance requirements, but not less than that specified for each application and metal.
- C. Fabricate sheet metal flashing and trim without excessive oil canning, buckling, and tool marks and true to line and levels indicated, with exposed edges folded back to form hems.
 - 1. Fabricate nonmoving seams in accessories with flat-lock seams. Tin edges to be seamed, form seams, and solder.

- D. Sealed Joints: Form nonexpansion but movable joints in metal to accommodate elastomeric sealant to comply with SMACNA recommendations.
- E. Expansion Provisions: Where lapped or bayonet-type expansion provisions in the Work cannot be used, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with butyl sealant concealed within joints.
- F. Conceal fasteners and expansion provisions where possible on exposed-to-view sheet metal flashing and trim, unless otherwise indicated.
- G. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.
 - 1. Thickness: As recommended by SMACNA's "Architectural Sheet Metal Manual" for application but not less than thickness of metal being secured.

2.05 WALL SHEET METAL FABRICATIONS

- A. Through-Wall Flashing: Fabricate continuous flashings in minimum 96 inch long, but not exceeding 12 foot long, sections, under copings, at shelf angles, and where indicated. Fabricate discontinuous lintel, sill, and similar flashings to extend 6 inches beyond each side of wall openings. Form with 2 inch high end dams. Fabricate from the following material:
 - 1. Stainless Steel: 0.0156 inch thick.

2.06 FINISHES

- A. Finish all exposed sheet metal trim to match metal wall panels.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions and other conditions affecting performance of work.
 - 1. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
 - 2. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION, GENERAL

- A. General: Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural movement. Use fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.
 - 1. Torch cutting of sheet metal flashing and trim is not permitted.

- B. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating or by other permanent separation as recommended by fabricator or manufacturers of dissimilar metals.
1. Coat side of uncoated stainless-steel and leadsheet metal flashing and trim with bituminous coating where flashing and trim will contact wood, ferrous metal, or cementitious construction.
 2. Underlayment: Where installing metal flashing directly on cementitious or wood substrates, install a course of EPDM underlayment and cover with a slip sheet. Lab underlayment joint 6 inches minimum with adhesive and lap joint sealant recommended by EMPD manufacturer.
 3. Bed flanges in thick coat of asphalt roofing cement where required for waterproof performance.
- C. Install exposed sheet metal flashing and trim without excessive oil canning, buckling, and tool marks.
- D. Install sheet metal flashing and trim true to line and levels indicated. Provide uniform, neat seams with minimum exposure of solder, welds, elastomeric and butyl sealant.
- E. Install sheet metal flashing and trim to fit substrates and to result in watertight performance. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.
1. Except where indicated to be continuous, space cleats not more than 12 inches apart.
 2. Anchor each cleat with two fasteners. Bend tabs over fasteners.
- F. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet with no joints allowed within 24 inches of corner or intersection. Where lapped or bayonet-type expansion provisions cannot be used or would not be sufficiently watertight, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with butyl sealant concealed within joints.
- G. Fasteners: Use fasteners of sizes that will penetrate substrate not less than 1-1/4 inches for nails and not less than 3/4 inch for wood screws.
1. Galvanized or Metallic-Coated Steel: Use stainless-steel fasteners.
 2. Stainless Steel: Use stainless-steel fasteners.
- H. Seal joints with elastomeric sealant as required for watertight construction.
1. Where sealant-filled joints are used, embed hooked flanges of joint members not less than 1 inch into sealant. Form joints to completely conceal sealant. When ambient temperature at time of installation is moderate, between 40 and 70 deg F, set joint members for 50 percent movement either way. Adjust setting proportionately for installation at higher ambient temperatures. Do not install sealant-type joints at temperatures below 40 deg F.
 2. Prepare joints and apply sealants to comply with requirements in Division 7 Section "Joint Sealants."

- I. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter. Pretin edges of sheets to be soldered to a width of 1-1/2 inches except where pretinned surface would show in finished Work.
 1. Pretinning is not required for lead.
 2. Stainless-Steel Soldering: Pretin edges of uncoated sheets to be soldered using solder recommended for stainless steel and phosphoric acid flux. Promptly wash off acid flux residue from metal after soldering.
 3. Where surfaces to be soldered are lead coated, do not tin edges, but wire brush lead coating before soldering.
 4. Do not use open-flame torches for soldering. Heat surfaces to receive solder and flow solder into joints. Fill joints completely. Completely remove flux and spatter from exposed surfaces.

3.03 ROOF FLASHING INSTALLATION

- A. General: Install sheet metal roof flashing and trim to comply with performance requirements and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, set units true to line, and level as indicated. Install work with laps, joints, and seams that will be permanently watertight.
- B. Counterflashing: Coordinate installation of counterflashing with installation of base flashing. Insert counterflashing in reglets or receivers and fit tightly to base flashing. Extend counterflashing 4 inches over base flashing. Lap counterflashing joints a minimum of 4 inches and bed with elastomeric sealant.
 1. Secure in a waterproof manner by one of following means as indicated on Drawings:
 - a. Snap-in installation and sealant or lead wedges and sealant.
 - b. Interlocking folded seam or blind rivets and sealant.
 - c. Anchor and washer at 36-inch centers.
- C. Roof-Penetration Flashing: Coordinate installation of roof-penetration flashing with installation of roofing and other items penetrating roof. Install flashing as follows:
 1. Seal with elastomeric sealant and clamp flashing to pipes penetrating roof except for lead flashing on vent piping.

3.04 WALL FLASHING INSTALLATION

- A. General: Install sheet metal wall flashing to intercept and exclude penetrating moisture according to SMACNA recommendations and as indicated. Coordinate installation of wall flashing with installation of wall-opening components such as windows, doors, and louvers.
- B. Reglets: Installation of reglets is specified in Division 03 precast concrete sections.

3.05 MISCELLANEOUS FLASHING INSTALLATION

- A. Equipment Support Flashing: Coordinate installation of equipment support flashing with installation of roofing and equipment.

3.06 CLEANING AND PROTECTION

- A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.
- B. Clean and neutralize flux materials. Clean off excess solder and sealants.
- C. Remove temporary protective coverings as sheet metal flashing and trim are installed. On completion of installation, clean finished surfaces, including removing unused fasteners, metal filings, pop rivet stems, and pieces of flashing. Maintain in a clean condition during construction.
- D. Replace sheet metal flashing and trim that have been damaged or that have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 07 62 00

SECTION 07 72 33**ROOF HATCHES****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. This Section includes roof hatches with integral safety post.
- B. Related Sections include the following:
 - 1. Division 05 Section "Metal Fabrications" for ladders and miscellaneous metal framing and supports.
 - 2. Division 06 Section "Miscellaneous Rough Carpentry" for wood nailers.
 - 3. Division 07 low-slope roofing Sections for roofing accessories.
 - 4. Division 07 Section "Sheet Metal Flashing and Trim" for shop- and field-fabricated metal flashing and counterflashing and miscellaneous sheet metal trim and accessories.

1.03 SUBMITTALS

- A. Product Data: For each type of roof accessory indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

1.04 QUALITY ASSURANCE

- A. Standards: Comply with the following:
 - 1. SMACNA's "Architectural Sheet Metal Manual" details for fabrication of units, including flanges and cap flashing to coordinate with type of roofing indicated.
 - 2. NRCA's "Roofing and Waterproofing Manual" details for installing units.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Pack, handle, and ship roof accessories properly labeled in heavy-duty packaging to prevent damage.

1.06 PROJECT CONDITIONS

- A. Field Measurements: Verify required openings for each type of roof accessory by field measurements before fabrication and indicate measurements on Shop Drawings.

1.07 COORDINATION

- A. Coordinate layout and installation of roof accessories with roofing membrane and base flashing and interfacing and adjoining construction to provide a leakproof, weathertight, secure, and noncorrosive installation.

PART 2 - PRODUCTS

2.01 METAL MATERIALS

- A. Galvanized Steel Sheet: ASTM A 653/A 653M, G90 coated and mill phosphatized for field painting.
- B. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A 792/A 792M, AZ50 coated.
- C. Steel Shapes: ASTM A 36/A 36M, hot-dip galvanized to comply with ASTM A 123/A 123M, unless otherwise indicated.
- D. Galvanized Steel Tube: ASTM A 500, round tube, hot-dip galvanized to comply with ASTM A 123/A 123M.
- E. Galvanized Steel Pipe: ASTM A 53/A 53M.

2.02 MISCELLANEOUS MATERIALS

- A. Glass-Fiber Board Insulation: ASTM C 726, 1 inch thick.
- B. Polyisocyanurate Board Insulation: ASTM C 1289, 1 inch thick.
- C. Felt: ASTM D 226, Type II (No. 30), asphalt-saturated organic felt, nonperforated.
 - 1. Slip Sheet: Rosin-sized paper, minimum 3 lb/100 sq. ft..
- D. Fasteners: Same metal as metals being fastened, or nonmagnetic stainless steel or other noncorrosive metal as recommended by roof accessory manufacturer. Match finish of exposed fasteners with finish of material being fastened. Provide nonremovable fastener heads to exterior exposed fasteners.
- E. Gaskets: Manufacturer's standard tubular or fingered design of neoprene, EPDM, or PVC; or flat design of foam rubber, sponge neoprene, or cork.

2.03 ROOF HATCHES

- A. Roof Hatches: Fabricate roof hatches with insulated double-wall lids and insulated single-wall curb frame with integral deck mounting flange and lid frame counterflashing. Fabricate with welded or mechanically fastened and sealed corner joints. Provide continuous weathertight perimeter gasketing and equip with corrosion-resistant or hot-dip galvanized hardware.
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Babcock-Davis; a Cierra Products Inc. Company.
 - b. Bilco Company (The).
 - c. Custom Curb, Inc.
 - d. Dur-Red Products.
 - e. J. L. Industries, Inc.
 - f. Nystrom, Inc.
 - g. Wasco Products, Inc.
 - 2. Loads: Fabricate roof hatches to withstand 40-lbf/sq. ft. external and 20-lbf/sq. ft. internal loads.
 - 3. Type and Size: Single-leaf lid, 36 x 78 inches unless indicated otherwise on Drawings.
 - 4. Curb Material: Galvanized or Aluminum-zinc alloy-coated steel sheet, 0.079 inch thick.

5. Lid Material: Aluminum sheet, 0.090 inch thick with mill finish.
6. Insulation: Glass-fiber or polyisocyanurate board.
7. Interior Lid Liner: Manufacturer's standard metal liner of same material and finish as outer metal lid.
8. Fabricate units to minimum height of 12 inches, unless otherwise indicated.
9. Hardware: Galvanized steel spring latch with turn handles, butt- or pintle-type hinge system, and padlock hasps inside and outside.
10. Ladder Safety Post: Manufacturer's standard ladder safety post. Post to lock in place on full extension. Provide release mechanism to return post to closed position.
 - a. Product: Subject to compliance with the requirements provide The Bilco Company; Model LU-1 or a comparable product by another available manufacturer.
 - b. Test Load: Single concentrated load of 200 pounds applied in any direction at any point at the top of post.
 - c. Height: 42 inches above finished roof deck.
 - d. Material and Finish: Steel tube, baked enameled.
 - e. Diameter: Pipe with 1-5/8-inch OD tube.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions, and other conditions affecting performance of work.
 1. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored and is ready to receive roof accessories.
 2. Verify dimensions of roof openings for roof accessories.
 3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. General: Install roof accessories according to manufacturer's written instructions. Anchor roof accessories securely in place and capable of resisting forces specified. Use fasteners, separators, sealants, and other miscellaneous items as required for completing roof accessory installation. Install roof accessories to resist exposure to weather without failing, rattling, leaking, and fastener disengagement.
- B. Install roof accessories to fit substrates and to result in watertight performance.
- C. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.
 1. Underlayment: Where installing exposed-to-view components of roof accessories directly on cementitious, install a course of felt underlayment and cover with a slip sheet.
- D. Install roof accessories level, plumb, true to line and elevation, and without warping, jogs in alignment, excessive oil canning, buckling, or tool marks.
- E. Roof Hatch Installation:

1. Check roof hatch for proper operation. Adjust operating mechanism as required. Clean and lubricate joints and hardware.
2. Attach ladder safety post according to manufacturer's written instructions.

3.03 TOUCH UP

- A. Touch up factory-primed surfaces with compatible primer ready for field painting in accordance with Division 09 painting Sections.

3.04 CLEANING

- A. Clean exposed surfaces according to manufacturer's written instructions.

END OF SECTION 07 72 33

SECTION 07 84 13**PENETRATION FIRESTOPPING****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. This Section includes the following:
 - 1. Through-penetration firestop systems for penetrations through the following fire-resistance-rated constructions, including both empty openings and openings containing penetrating items:
 - a. 1-hour rated concrete floors/ceiling and roof/ceiling decks.
 - b. 1 hour rated masonry partitions.
 - c. 1-hour rated gypsum board partitions.
 - d. 3-hour rated masonry partitions.
 - 2. Through-penetration firestop system schedule.
- B. Related Sections include the following:
 - 1. Division 07 Section "Fire-Resistive Joint Systems."
 - 2. Division 21 Sections specifying fire-suppression piping penetrations.
 - 3. Division 22 and 23 Sections specifying duct and piping penetrations.
 - 4. Division 26, 27, and 28 Sections specifying cable and conduit penetrations.

1.03 PERFORMANCE REQUIREMENTS

- A. General: For penetrations through the following fire-resistance-rated constructions, including both empty openings and openings containing penetrating items, provide through-penetration firestop systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated.
 - 1. Fire-resistance-rated walls including fire walls, fire partitions, fire barriers and smoke barriers.
- B. Rated Systems: Provide through-penetration firestop systems with the following ratings determined per ASTM E 814:
 - 1. F-Rated Systems: Provide through-penetration firestop systems with F-ratings indicated, but not less than that equaling or exceeding fire-resistance rating of constructions penetrated.
 - 2. T-Rated Systems: For the following conditions, provide through-penetration firestop systems with T-ratings indicated, as well as F-ratings, where systems protect penetrating items exposed to potential contact with adjacent materials in

occupiable floor areas:

- a. Penetrations located outside wall cavities.
 - b. Penetrations located outside fire-resistance-rated shaft enclosures.
- C. For through-penetration firestop systems exposed to view, traffic, moisture, and physical damage, provide products that, after curing, do not deteriorate when exposed to these conditions both during and after construction.
1. For piping penetrations for plumbing and wet-pipe sprinkler systems, provide moisture-resistant through-penetration firestop systems.
 2. For penetrations involving insulated piping, provide through-penetration firestop systems not requiring removal of insulation.
- D. For through-penetration firestop systems exposed to view, provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.

1.04 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. LEED Submittals:
1. Product Data for Credit IEQ 4.1: For penetration firestopping sealants and sealant primers, documentation including printed statement of VOC content.
- C. Product Schedule: For each penetration firestopping system. Include location and design designation of qualified testing and inspecting agency.
1. Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular penetration firestopping condition, submit illustration, with modifications marked, approved by penetration firestopping manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly.
- D. Qualification Data: For qualified Installer.
- E. Installer Certificates: From Installer indicating penetration firestopping has been installed in compliance with requirements and manufacturer's written recommendations.
- F. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for penetration firestopping.

1.05 QUALITY ASSURANCE

- A. Installer Qualifications: A firm experienced in installing through-penetration firestop systems similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful performance. Qualifications include having the necessary experience, staff, and training to install manufacturer's products per specified requirements. Manufacturer's willingness to sell its through-penetration firestop system products to Contractor or to Installer engaged by Contractor does not in itself confer qualification on buyer.

- B. Installation Responsibility: Assign installation of through-penetration firestop systems in Project to a single qualified installer.
- C. Source Limitations: Obtain through-penetration firestop systems, for each kind of penetration and construction condition indicated, through one source from a single manufacturer.
- D. Fire-Test-Response Characteristics: Provide through-penetration firestop systems that comply with the following requirements and those specified in Part 1 "Performance Requirements" Article:
 - 1. Firestopping tests are performed by a qualified testing and inspecting agency. A qualified testing and inspecting agency is UL or another agency performing testing and follow-up inspection services for firestop systems acceptable to authorities having jurisdiction.
 - 2. Through-penetration firestop systems are identical to those tested per testing standard referenced in "Part 1 Performance Requirements" Article. Provide rated systems complying with the following requirements:
 - a. Through-penetration firestop system products bear classification marking of qualified testing and inspecting agency.
 - b. Through-penetration firestop systems correspond to those indicated by reference to through-penetration firestop system designations listed by the following:
 - 1) UL in its "Fire Resistance Directory."
- E. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver through-penetration firestop system products to Project site in original, unopened containers or packages with intact and legible manufacturers' labels identifying product and manufacturer, date of manufacture, lot number, shelf life if applicable, qualified testing and inspecting agency's classification marking applicable to Project, curing time, and mixing instructions for multicomponent materials.
- B. Store and handle materials for through-penetration firestop systems to prevent their deterioration or damage due to moisture, temperature changes, contaminants, or other causes.

1.07 PROJECT CONDITIONS

- A. Environmental Limitations: Do not install through-penetration firestop systems when ambient or substrate temperatures are outside limits permitted by through-penetration firestop system manufacturers or when substrates are wet due to rain, frost, condensation, or other causes.
- B. Ventilate through-penetration firestop systems per manufacturer's written instructions by natural means or, where this is inadequate, forced-air circulation.

1.08 COORDINATION

- A. Coordinate construction of openings and penetrating items to ensure that through-penetration firestop systems are installed according to specified requirements.
- B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate through-penetration firestop systems.
- C. Notify Authority's inspecting agency at least seven days in advance of through-penetration firestop system installations; confirm dates and times on days preceding each series of installations.
- D. Do not cover up through-penetration firestop system installations that will become concealed behind other construction until each installation has been examined by Authority's inspecting agency and building inspector, if required by authorities having jurisdiction.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Available Products: Subject to compliance with requirements, through-penetration firestop systems that may be incorporated into the Work include, but are not limited to, those systems indicated in the Through-Penetration Firestop System Schedule at the end of Part 3 that are produced by one of the following manufacturers:
 - 1. Hilti Construction Chemicals, Inc. (Hilti)
 - 2. Nelson Firestop Products (Nelson).
 - 3. Specified Technologies Inc. (STI).
 - 4. 3M; Fire Protection Products Division (3M).

2.02 FIRESTOPPING, GENERAL

- A. Provide penetration firestopping that is produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated. Penetration firestopping systems shall be compatible with one another, with the substrates forming openings, and with penetrating items if any.
- B. Accessories: Provide components for each through-penetration firestop system that are needed to install fill materials and to comply with Part 1 "Performance Requirements" Article. Use only components specified by through-penetration firestop system manufacturer and approved by qualified testing and inspecting agency for firestop systems indicated. Accessories include, but are not limited to, the following items:
 - 1. Permanent forming/damming/backing materials, including the following:
 - a. Slag-/rock-wool-fiber insulation.
 - b. Sealants used in combination with other forming/damming/backing materials to prevent leakage of fill materials in liquid state.
 - c. Fire-rated form board.
 - d. Fillers for sealants.

2. Temporary forming materials.
 3. Substrate primers.
 4. Collars.
 5. Steel sleeves.
- C. VOC Content: Penetration firestopping sealants and sealant primers shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
1. Sealants: 250 g/L.
 2. Sealant Primers for Nonporous Substrates: 250 g/L.
 3. Sealant Primers for Porous Substrates: 775 g/L.

2.03 FILL MATERIALS

- A. General: Provide through-penetration firestop systems containing the types of fill materials indicated in the Through-Penetration Firestop System Schedule at the end of Part 3 by referencing the types of materials described in this Article. Fill materials are those referred to in directories of referenced testing and inspecting agencies as "fill," "void," or "cavity" materials.
- B. Latex Sealants: Single-component latex formulations that after cure do not re-emulsify during exposure to moisture.
- C. Firestop Devices: Factory-assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrant.
- D. Intumescent Composite Sheets: Rigid panels consisting of aluminum-foil-faced elastomeric sheet bonded to galvanized steel sheet.
- E. Intumescent Putties: Nonhardening dielectric, water-resistant putties containing no solvents, inorganic fibers, or silicone compounds.
- F. Intumescent Wrap Strips: Single-component intumescent elastomeric sheets with aluminum foil on one side.
- G. Mortars: Prepackaged dry mixes consisting of a blend of inorganic binders, hydraulic cement, fillers, and lightweight aggregate formulated for mixing with water at Project site to form a nonshrinking, homogeneous mortar.
- H. Pillows/Bags: Reusable heat-expanding pillows/bags consisting of glass-fiber cloth cases filled with a combination of mineral-fiber, water-insoluble expansion agents, and fire-retardant additives.
- I. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.
- J. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below:
 1. Grade: nonsag formulation for openings in vertical and other surfaces requiring a nonslumping, gunnable sealant.

2.04 MIXING

- A. For those products requiring mixing before application, comply with through-penetration firestop system manufacturer's written instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Surface Cleaning: Clean out openings immediately before installing through-penetration firestop systems to comply with firestop system manufacturer's written instructions and with the following requirements:
 - 1. Remove from surfaces of opening substrates and from penetrating items foreign materials that could interfere with adhesion of through-penetration firestop systems.
 - 2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with through-penetration firestop systems. Remove loose particles remaining from cleaning operation.
 - 3. Remove laitance and form-release agents from concrete.
- B. Priming: Prime substrates where recommended in writing by through-penetration firestop system manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.
- C. Masking Tape: Use masking tape to prevent through-penetration firestop systems from contacting adjoining surfaces that will remain exposed on completion of Work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to remove smears from firestop system materials. Remove tape as soon as possible without disturbing firestop system's seal with substrates.

3.03 THROUGH-PENETRATION FIRESTOP SYSTEM INSTALLATION

- A. General: Install through-penetration firestop systems to comply with Part 1 "Performance Requirements" Article and with firestop system manufacturer's written installation instructions and published drawings for products and applications indicated.

- B. Install forming/damming/backing materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.
 - 1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of firestop systems.
- C. Install fill materials for firestop systems by proven techniques to produce the following results:
 - 1. Fill voids and cavities formed by openings, forming materials, accessories, and penetrating items as required to achieve fire-resistance ratings indicated.
 - 2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
 - 3. For fill materials that will remain exposed after completing Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.04 IDENTIFICATION

- A. Identify through-penetration firestop systems with preprinted metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches of edge of the firestop systems so that labels will be visible to anyone seeking to remove penetrating items or firestop systems. Use mechanical fasteners for metal labels. For plastic labels, use self-adhering type with adhesives capable of permanently bonding labels to surfaces on which labels are placed and, in combination with label material, will result in partial destruction of label if removal is attempted. Include the following information on labels:
 - 1. The words "Warning - Through-Penetration Firestop System - Do Not Disturb. Notify Building Management of Any Damage."
 - 2. Contractor's name, address, and phone number.
 - 3. Through-penetration firestop system designation of applicable testing and inspecting agency.
 - 4. Date of installation.
 - 5. Through-penetration firestop system manufacturer's name.
 - 6. Installer's name.

3.05 FIELD QUALITY CONTROL

- A. Inspecting Agency: Authority will engage a qualified, independent inspecting agency to inspect through-penetration firestops. Independent inspecting agency shall comply with ASTM E 2174 requirements including those related to qualifications, conducting inspections, and preparing test reports.
- B. Where deficiencies are found, repair or replace through-penetration firestop systems so they comply with requirements.
- C. Proceed with enclosing through-penetration firestop systems with other construction only after inspection reports are issued and firestop installations comply with requirements.

3.06 CLEANING AND PROTECTING

- A. Clean off excess fill materials adjacent to openings as Work progresses by methods and with cleaning materials that are approved in writing by through-penetration firestop system manufacturers and that do not damage materials in which openings occur.
- B. Provide final protection and maintain conditions during and after installation that ensure that through-penetration firestop systems are without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated through-penetration firestop systems immediately and install new materials to produce systems complying with specified requirements.
- C. Construction Waste Management and Disposal: Comply with Waste Management Plan required under Division 01 Section "Construction Waste Management And Disposal."

3.07 THROUGH-PENETRATION FIRESTOP SYSTEM SCHEDULE

- A. Where UL-classified systems are indicated, they refer to alpha-alpha-numeric designations listed in UL's "Fire Resistance Directory" under product Category XHEZ.
- B. General:
 - 1. N/A* indicates that no UL-Classified system is available for manufacturer indicated. Manufacturer may provide engineer judgment drawing acceptable to Authorities having jurisdiction.
 - 2. Jobsite conditions of each through-penetration firestop system shall meet all details of the UL-Classified System selected.
 - 3. If jobsite conditions do not match any UL-classified systems scheduled below then contact firestop manufacturer for alternative systems or engineer judgment drawings.
 - 4. Where more than one applicable UL-Classified System is listed in the schedules, choose the UL System which is most economical for each through-penetration firestop system.
 - 5. Coordinate work with other trades to assure that penetration opening sizes are appropriate for penetrant locations, and vice versa.
- C. Concrete Walls:

CONCRETE WALLS		UL-CLASSIFIED SYSTEMS			
TYPE OF PENETRANT	F-RATING (HR)	HILTI	3M	STI	NELSON
CIRCULAR BLANK OPENINGS	2	CAJ 0055, CAJ 0070	CAJ 0009	CAJ 0006	CAJ 0043
SINGLE METAL PIPES OR CONDUIT	2	CAJ 1226, WJ 1021	CAJ 1058	CAJ 1079, WJ 1070	CAJ 1040
SINGLE NON-METALLIC PIPE OR CONDUIT (I.E. PVC, CPVC, ABS, ENT)	2	CAJ 2109, CAJ 2098	CAJ 2189, CAJ 2117, CAJ 2027	CAJ 2089, CAJ 2031	CAJ 2096

CONCRETE WALLS		UL-CLASSIFIED SYSTEMS			
TYPE OF PENETRANT	F-RATING (HR)	HILTI	3M	STI	NELSON
SINGLE OR BUNDLED CABLES	2	WJ 3036, CAJ 3095, CAJ 3096	CAJ 3021	CAJ 3154	CAJ 3090
CABLE TRAY	2	WJ 4016, CAJ 4034, CAJ 4035	CAJ 4003	CAJ 4029, WJ 4022	CAJ 4001
SINGLE INSULATED PIPES	2	CAJ 5090, CAJ 5091, CAJ 5061	CAJ 5080, CAJ 5024, CAJ 5017	CAJ 5103, CAJ 5079, CAJ 5087	CAJ 5203 CAJ 5104
ELECTRICAL BUSWAY	2	CAJ 6006, CAJ 6017	CAJ 6001, CAJ 6002	N/A*	CAJ 6004
NON-INSULATED MECHANICAL DUCTWORK WITHOUT DAMPERS	2	CAJ 7046, CAJ 7051, WJ 7021, WJ 7022	CAJ 7003, CAJ 7021	CAJ 7027, CAJ 7023, WJ 7007	CAJ 7079 CAJ 7078
MIXED PENETRANTS	2	CAJ 8041, CAJ 8056 W J 8007	CAJ 8001, CAJ 8013	CAJ 8053, CAJ 1208	CAJ 8118

D. Gypsum Wallboard Assemblies:

GYPSUM WALLBOARD ASSEMBLIES		UL-CLASSIFIED SYSTEMS			
TYPE OF PENETRANT	F-RATING (HR)	HILTI	3M	STI	NELSON
METAL PIPES OR CONDUIT	1	WL 1054, WL 1058, WL 1164	WL 1146	WL 1049, WL 1078	WL 1276
	2	WL 1054, WL 1058, WL 1164	WL 1010, WL 1146	WL 1049, WL 1078	WL 1276
NON-METALLIC PIPE OR CONDUIT	1	WL 2078, WL 2075, WL 2128	WL 2088, WL 2002	WL 2074, WL 2059	WL 2291, WL 2306
	2	WL 2078, WL 2075, WL 2128	WL 2088, WL 2002	WL 2074, WL 2059	WL 2291, WL 2131
SINGLE OR BUNDLED CABLES	1	WL 3065, WL 3111, WL 3112	WL 3032, WL 3030	WL 3132, W L 3134	WL 3204, WL 3202
	2	WL 3065, WL 3111, WL 3112	WL 3032, WL 3030	WL 3132, W L 3134	WL 3204, WL 3202
CABLE TRAY	1	WL 4011, WL 4019	WL 4004	WL 4005, WL 4008	WL 4003

GYPSUM WALLBOARD ASSEMBLIES		UL-CLASSIFIED SYSTEMS			
TYPE OF PENETRANT	F-RATING (HR)	HILTI	3M	STI	NELSON
	2	WL 4011, WL 4019	WL 4004	WL 4005, WL 4008	WL 4003
	4	WL 8014	N/A*	N/A*	N/A*
INSULATED PIPES	1	WL 5028, WL 5029, WL 5047	WL 5040, WL 5001, WL 5032	WL 5033, WL 5054, WL 5091	WL 5161, WL 5178
	2	WL 5028, WL 5029, WL 5047	WL 5040, WL 5001, WL 5032	WL 5033, WL 5054, WL 5091	WL 5161, WL 5178
NON-INSULATED MECHANICAL DUCTWORK WITHOUT DAMPERS	1	WL 7017, WL 7040, WL 7042	WL 7008	WL 7025, WL 7019, WL 7009	WL 7084, WL 7085
	2	WL 7040, WL 7042	WL 7008, WL 7013, WL 7016	WL 7025, WL 7019, WL 7009	WL 7084, WL 7085, WL 7092
MIXED PENETRANTS	1	WL 1095, WL 8013	WL 8010	WL 8003, WL 8011	N/A*
	2	WL 1095, WL 8013	WL 8010, WL 8002	WL 8003, WL 8011	N/A*

END OF SECTION 07 84 13

SECTION 07 84 46**FIRE-RESISTIVE JOINT SYSTEMS FOR WALLS****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section Includes joints in or between fire-resistance-rated constructions and fire-resistive joint system schedule.
- B. Related Sections:
 - 1. Division 07 Section "Penetration Firestopping" for penetrations in fire-resistance-rated walls, horizontal assemblies, and smoke barriers.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. LEED Submittals:
 - 1. Product Data for Credit IEQ 4.1: For fire-resistive joint system sealants, documentation including printed statement of VOC content.
- C. Product Schedule: For each fire-resistive joint system. Include location and design designation of qualified testing agency.
- D. Where Project conditions require modification to a qualified testing agency's illustration for a particular fire-resistive joint system condition, submit illustration, with modifications marked, approved by fire-resistive joint system manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly.

1.04 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Installer Certificates: From Installer indicating fire-resistive joint systems have been installed in compliance with requirements and manufacturer's written recommendations.
- C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for fire-resistive joint systems.

1.05 QUALITY ASSURANCE

- A. **Installer Qualifications:** A firm experienced in installing fire-resistive joint systems similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful performance. Qualifications include having the necessary experience, staff, and training to install manufacturer's products per specified requirements. Manufacturer's willingness to sell its fire-resistive joint system products to Contractor or to Installer engaged by Contractor does not in itself confer qualification on buyer.
- B. **Fire-Test-Response Characteristics:** Fire-resistive joint systems shall comply with the following requirements:
 - 1. Fire-resistive joint system tests are performed by a qualified testing agency acceptable to authorities having jurisdiction.
 - 2. Fire-resistive joint systems are identical to those tested per testing standard referenced in "Fire-Resistive Joint Systems" Article. Provide rated systems complying with the following requirements:
 - a. Fire-resistive joint system products bear classification marking of qualified testing agency.
 - b. Fire-resistive joint systems correspond to those indicated by reference to designations listed by UL in its "Fire Resistance Directory."
- C. **Preinstallation Conference:** Conduct conference at Project site.

1.06 PROJECT CONDITIONS

- A. **Environmental Limitations:** Do not install fire-resistive joint systems when ambient or substrate temperatures are outside limits permitted by fire-resistive joint system manufacturers or when substrates are wet due to rain, frost, condensation, or other causes.
- B. Install and cure fire-resistive joint systems per manufacturer's written instructions using natural means of ventilation or, where this is inadequate, forced-air circulation.

1.07 COORDINATION

- A. Coordinate construction of joints to ensure that fire-resistive joint systems are installed according to specified requirements.
- B. Coordinate sizing of joints to accommodate fire-resistive joint systems.

PART 2 - PRODUCTS

2.01 FIRE-RESISTIVE JOINT SYSTEMS

- A. Where required, provide fire-resistive joint systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of assemblies in or between which fire-resistive joint systems are installed. Fire-resistive joint systems shall accommodate building movements without impairing their ability to resist the passage of fire and hot gases.
- B. **Joints in or between Fire-Resistance-Rated Construction:** Provide fire-resistive joint systems with ratings determined per ASTM E 1966 or UL 2079:

1. Joints include those installed in or between fire-resistance-rated walls, floor or floor/ceiling assemblies, and roofs or roof/ceiling assemblies.
 2. Fire-Resistance Rating: Equal to or exceeding the fire-resistance rating of construction they will join.
 3. Basis-of-Design Manufacturer: Subject to compliance with requirements, provide Hilti, Inc., UL-Classified Systems indicated in Part 3 Article "Fire-Resistive Joint System Schedule" or comparable systems by one of the following:
 - a. Nelson Firestop Products.
 - b. Specified Technologies Inc.
 - c. 3M Fire Protection Products.
- C. Exposed Fire-Resistive Joint Systems: Provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.
- D. VOC Content: Provide fire-resistive joint systems that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
1. Architectural Sealants: 250 g/L.
 2. Sealant Primers for Nonporous Substrates: 250 g/L.
 3. Sealant Primers for Porous Substrates: 775 g/L.
- E. Accessories: Provide components of fire-resistive joint systems, including primers and forming materials, that are needed to install fill materials and to maintain ratings required. Use only components specified by fire-resistive joint system manufacturer and approved by the qualified testing agency for systems indicated.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for joint configurations, substrates, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Surface Cleaning: Clean joints immediately before installing fire-resistive joint systems to comply with fire-resistive joint system manufacturer's written instructions and the following requirements:
 1. Remove from surfaces of joint substrates foreign materials that could interfere with adhesion of fill materials.
 2. Clean joint substrates to produce clean, sound surfaces capable of developing optimum bond with fill materials. Remove loose particles remaining from cleaning operation.
 3. Remove laitance and form-release agents from concrete.
- B. Masking Tape: Use masking tape to prevent fill materials of fire-resistive joint system from contacting adjoining surfaces that will remain exposed on completion of the Work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to remove stains. Remove tape as soon as possible without disturbing fire-resistive joint system's seal with substrates.

3.03 INSTALLATION

- A. General: Install fire-resistive joint systems to comply with manufacturer's written installation instructions and published drawings for products and applications indicated.
- B. Install forming materials and other accessories of types required to support fill materials during their application and in position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.
 - 1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of fire-resistive joint system.
- C. Install fill materials for fire-resistive joint systems by proven techniques to produce the following results:
 - 1. Fill voids and cavities formed by joints and forming materials as required to achieve fire-resistance ratings indicated.
 - 2. Apply fill materials so they contact and adhere to substrates formed by joints.
 - 3. For fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.04 CLEANING AND PROTECTING

- A. Clean off excess fill materials adjacent to joints as the Work progresses by methods and with cleaning materials that are approved in writing by fire-resistive joint system manufacturers and that do not damage materials in which joints occur.
- B. Provide final protection and maintain conditions during and after installation that ensure fire-resistive joint systems are without damage or deterioration at time of Substantial Completion. If damage or deterioration occurs despite such protection, cut out and remove damaged or deteriorated fire-resistive joint systems immediately and install new materials to produce fire-resistive joint systems complying with specified requirements.
- C. Construction Waste Management and Disposal:
 - 1. Comply with Waste Management Plan required under Division 01 Section "Construction Waste Management And Disposal."

3.05 FIRE-RESISTIVE JOINT SYSTEM SCHEDULE

- A. Where UL-classified systems are indicated, they refer to system numbers in UL's "Fire Resistance Directory" under product Category XHBN.

- B. Wall-to-Wall, Fire-Resistive Joint Systems: UL-Classified WW-D Systems including the following:

Basis-of-Design UL System No.	Applications	Max. Fire Rating (Hour)	Max. Joint Width (inch)	Class	Compression %	Extension %
WW-D-0064	Cast-in-place concrete or concrete masonry units to cast-in-place concrete or concrete masonry units	3	2	II	6	6

- C. Head-of-Wall, Fire-Resistive Joint Systems: UL-Classified HW-D Systems including the following:

Basis-of-Design UL System No.	Applications	Max. Fire Rating (Hour)	Max. Joint Width (inch)	Class	Compression %	Extension %
HW-D-0042	Gypsum board wall perpendicular to flutes of concrete filled metal deck	2	1	II	50	50
HW-D-0049	Gypsum board wall parallel to flutes of concrete filled metal deck	2	1	II	50	50
HW-D-2018	Gypsum board wall at beam or joist supporting concrete filled metal deck	2	1	II	25	25
HW-D-0259	Gypsum board wall at centerline of beam supporting concrete filled metal deck	2	1	II	25	25

END OF SECTION 07 84 46

SECTION 07 92 00**JOINT SEALANTS****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY**A. Section Includes:**

1. Joints sealed with following materials:
 - a. Silicone joint sealants.
 - b. Urethane joint sealants.
 - c. Latex joint sealants.
 - d. Solvent-release-curing joint sealants.
2. Sealant selection tables for following applications:
 - a. Table 1: Exterior joints in vertical surfaces and horizontal nontraffic surfaces (not subject to water immersion) (including ceilings and soffits).
 - b. Table 3: Interior joints in vertical surfaces and horizontal nontraffic surfaces (including ceilings).
 - c. Table 4: Interior joints in horizontal traffic surfaces.
 - d. Table 5 Mildew-resistant interior joints in vertical surfaces and horizontal nontraffic surfaces (including ceilings). Locations include rooms containing sinks, showers, toilets, urinals, and similar plumbing fixtures.

B. Related Sections:

1. Section 03 15 23 "Expansion Joint Seals in Concrete" for expansion joints in cast-in-place or precast concrete.
2. Section 04 20 00 "Unit Masonry" for masonry control and expansion joint fillers and gaskets.
3. Section 07 95 00 "Expansion Control" for building expansion joints.
4. Section 07 84 46 "Fire-Resistive Joint Systems" for sealing joints in fire-resistance-rated construction.
5. Section 08 80 00 "Glazing" for glazing sealants.
6. Section 09 29 00 "Gypsum Board" for sealing perimeter joints.
7. Section 09 30 00 "Tiling" for sealing tile joints.
8. Section 32 13 73 "Concrete Paving Joint Sealants" for sealing joints in pavements, walkways, and curbing.

C. Sealant Selection Tables:

1. Table 1: Exterior Joints in Vertical Surfaces and Horizontal Nontraffic Surfaces (Not Subject to Water Immersion) (Including Ceilings and Soffits):

Surface Material	Joint Type	Sealant Type	
Between concrete or unit masonry and perimeter of frames of doors, windows and louvers.	Perimeter joints (not expansion joint).	JS-01, JS-02, JS-03, JS-07	Non-staining type where indicated above.
	Expansion joints.	JS-01	
Other joints as indicated on Drawings.			

D. Table 2: Interior Joints in Vertical Surfaces and Horizontal Nontraffic Surfaces (Including Ceilings):

Material	Joint Type	Sealant Type
Exposed interior surfaces of exterior walls.	Control joints.	JS-50, JS-60
	Expansion joints	See Section 07 95 00 "EXPANSION CONTROL"
Perimeter joints of exterior openings where indicated.	Perimeter joints (not expansion joint).	JS-50, JS-60
	Expansion joints.	See Section 07 95 00 "EXPANSION CONTROL"
Ceramic tile	Control joints.	See Section 09 30 00 "TILING"
	Expansion joints.	See Section 07 95 00 "EXPANSION CONTROL"
Exposed surfaces of interior unit masonry partitions.	Vertical control joints.	JS-50, JS-60
	Vertical expansion joints.	See Section 07 95 00 "EXPANSION CONTROL"
Between interior wall surfaces and frames of interior doors windows and elevator entrances.	Perimeter joints (not expansion joint).	JS-50, JS-60
	Expansion joints.	See Section 07 95 00 "EXPANSION CONTROL"

E. Table 3: Interior Joints in Horizontal Traffic Surfaces:

Material	Joint Type	Sealant Type
----------	------------	--------------

Material	Joint Type	Sealant Type
Cast-in-place concrete slabs.	Control joints.	See Section 03 30 00 "CAST-IN-PLACE CONCRETE" for semirigid joint filler.
	Isolation joints.	JS-05, JS-06, JS-08
Ceramic tile flooring.	Control joints.	JS-05, JS-06, JS-08, JS-23, JS-24, JS-27, JS-28
	Expansion joints.	See Section 07 95 00 "EXPANSION CONTROL"

F. Table 4: Mildew-Resistant Interior Joints in Vertical Surfaces and Horizontal Nontraffic Surfaces (Including Ceilings). Locations include rooms containing sinks, showers, toilets, urinals, and similar plumbing fixtures:

Material	Joint Type	Sealant Type
Plumbing fixtures and adjoining walls, floors, and counters.	Joints between fixture and adjacent surface.	JS-09, JS-10
Ceramic tile.	Control joints.	JS-09, JS-10
	Joints at inside corners, vertical and horizontal.	JS-09, JS-10
	Expansion joints.	See Section 07 95 00 "EXPANSION CONTROL"

1.03 REFERENCES

A. Definitions:

1. Isolation Joints: Junctions of horizontal surfaces with vertical surfaces where each surface is not structurally connected and is allowed to move independently.
 - a. Horizontal surfaces include the following:
 - 1) Concrete slabs-on-grade.
 - b. Vertical surfaces include the following:
 - 1) Foundation walls.
 - 2) Exterior walls, including those with veneers.

- 3) Storefronts.
 - 4) Curtainwalls.
2. Reference Standards:
- a. ASTM C834-10 Standard Specification for Latex Sealants.
 - b. ASTM C920-11 Standard Specification for Elastomeric Joint Sealants.
 - c. ASTM C1021-08 Standard Practice for Laboratories Engaged in Testing of Building Sealants.
 - d. ASTM C1087-00(2011) Standard Test Method for Determining Compatibility of Liquid-Applied Sealants with Accessories Used in Structural Glazing Systems.
 - e. ASTM C1193-11a Standard Guide for Use of Joint Sealants.
 - f. ASTM C1247-09 Standard Test Method for Durability of Sealants Exposed to Continuous Immersion in Liquids.
 - g. ASTM C1248-08 Standard Test Method for Staining of Porous Substrate by Joint Sealants.
 - h. ASTM C1311-10 Standard Specification for Solvent Release Sealants.
 - i. ASTM C1330-02(2007) Standard Specification for Cylindrical Sealant Backing for Use with Cold Liquid Applied Sealants.
 - j. ASTM C1521-09e1 Standard Practice for Evaluating Adhesion of Installed Weatherproofing Sealant.

1.04 PRECONSTRUCTION TESTING

- A. Preconstruction Field-Adhesion Testing: Before installing sealants, field test their adhesion to Project joint substrates as follows:
1. Locate test joints where indicated on Project or, if not indicated, as directed by Authority.
 2. Conduct field tests for each application indicated below:
 - a. Each kind of sealant and joint substrate indicated.
 3. Notify Authority seven days in advance of dates and times when test joints will be erected.
 4. Arrange for tests to take place with joint-sealant manufacturer's technical representative present.
 - a. Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1 in ASTM C 1193 or Method A, Tail Procedure, in ASTM C 1521.
 - 1) For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.
 5. Report whether sealant failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. For sealants that fail adhesively, retest until satisfactory adhesion is obtained.
 6. Evaluation of Preconstruction Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing, in absence of other indications of noncompliance with requirements, will be considered satisfactory. Do not use sealants that fail to adhere to joint substrates during testing.

1.05 ACTION SUBMITTALS

- A. Product Data: For each joint-sealant product indicated.
- B. LEED Submittals:
 - 1. Product Data for Credit IEQ 4.1: For sealants and sealant primers used inside the weatherproofing system, documentation including printed statement of VOC content.
- C. Samples for Initial Selection: Manufacturer's color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.
- D. Samples for Verification: For each kind and color of joint sealant required, provide Samples with joint sealants in 1/2-inch- wide joints formed between two 6-inch- long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.

1.06 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, indicating that sealants comply with requirements.
- C. Field-Adhesion Test Reports: For each sealant application tested.
- D. Warranties: Sample of special warranties.

1.07 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
- B. Source Limitations: Obtain each kind of joint sealant from single source from single manufacturer.
- C. Mockups: Install sealant in mockups of assemblies specified in other Sections that are indicated to receive joint sealants specified in this Section. Use materials and installation methods specified in this Section.
- D. Preinstallation Conference: Conduct conference at Project site.

1.08 PROJECT CONDITIONS

- A. Do not proceed with installation of joint sealants under the following conditions:
 - 1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F.
 - 2. When joint substrates are wet.
 - 3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
 - 4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

1.09 WARRANTY

- A. Special Installer's Warranty: Manufacturer's standard form in which Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
1. Warranty Period:
 - a. Sealants Exposed to Exterior: Two years from date of Substantial Completion.
 - b. Sealants Exposed to Interior: One year from date of Substantial Completion.
- B. Special Manufacturer's Warranty: Manufacturer's standard form in which joint-sealant manufacturer agrees to furnish joint sealants to repair or replace those that do not comply with performance and other requirements specified in this Section within specified warranty period.
1. Warranty Period:
 - a. Silicone Joint Sealants: 20 years from date of Substantial Completion.
 - b. Urethane Joint Sealants: 5 years from date of Substantial Completion.
- C. Special warranties specified in this article exclude deterioration or failure of joint sealants from the following:
1. Movement of the structure caused by structural settlement or errors attributable to design or construction resulting in stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression.
 2. Disintegration of joint substrates from natural causes exceeding design specifications.
 3. Mechanical damage caused by individuals, tools, or other outside agents.
 4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

PART 2 - PRODUCTS

2.01 MATERIALS, GENERAL

- A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.
- B. VOC Content of Interior Sealants: Sealants and sealant primers used inside the weatherproofing system shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
1. Architectural Sealants: 250 g/L.
 2. Sealant Primers for Nonporous Substrates: 250 g/L.
 3. Sealant Primers for Porous Substrates: 775 g/L.
- C. Liquid-Applied Joint Sealants: Comply with ASTM C 920 and other requirements indicated for each liquid-applied joint sealant specified, including those referencing ASTM C 920 classifications for type, grade, class, and uses related to exposure and joint substrates.

- D. Stain-Test-Response Characteristics: Where sealants are specified to be nonstaining to porous substrates, provide products that have undergone testing according to ASTM C 1248 and have not stained porous joint substrates indicated for Project.
- E. Colors of Exposed Joint Sealants: As selected by Authority from manufacturer's full range of colors, except match color of substrate being sealed for the following:
 - 1. Concrete.
 - 2. Masonry mortar for CMU.
 - 3. Prefinished metal.

2.02 SILICONE JOINT SEALANTS

- A. JS-01 - Single-Component, Nonsag, Neutral-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 100/50, for Use NT.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Dow Corning Corporation; 790 or NS Parking Structure Sealant.
 - b. GE Advanced Materials - Silicones; SilPruf LM SCS2700.
 - c. May National Associates, Inc.; Bondaflex Sil 290 or Bondaflex Sil 728 NS.
 - d. Pecora Corporation; 301 NS, 311 NS, 890, or 890FTS.
 - e. Sika Corporation, Construction Products Division; SikaSil-C990.
 - f. Tremco Incorporated; Spectrem 1 or Spectrem 800.
- B. JS-02 - Single-Component, Nonsag, Neutral-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 50, for Use NT.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. BASF Building Systems; Omniseal 50.
 - b. Dow Corning Corporation; 756 SMS, 791, 795, or 995.
 - c. GE Advanced Materials - Silicones; SilGlaze II SCS2800, SilPruf NB SCS9000, SilPruf SCS2000, or UltraPruf II SCS2900.
 - d. May National Associates, Inc.; Bondaflex Sil 295.
 - e. Pecora Corporation; 864, 895, or 898.
 - f. Polymeric Systems, Inc.; PSI-641.
 - g. Sika Corporation, Construction Products Division; SikaSil-C995.
 - h. Tremco Incorporated; Spectrem 2 or Spectrem 3.
- C. JS-03 - Single-Component, Nonsag, Neutral-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 25, for Use NT.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Dow Corning Corporation; 799.
 - b. GE Advanced Materials - Silicones; UltraGlaze SSG4000 or UltraGlaze SSG4000AC.
 - c. May National Associates, Inc.; Bondaflex Sil 200 GPN or Bondaflex Sil 201 FC.
 - d. Polymeric Systems, Inc.; PSI-631.
 - e. Schnee-Morehead, Inc.; SM5731 Poly-Glaze Plus.
 - f. Tremco Incorporated; Proglaze SSG or Tremsil 600.
- D. JS-04 - Single-Component, Nonsag, Acid-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 25, for Use NT.

1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Bostik, Inc.; Chem-Calk 1200.
 - b. Dow Corning Corporation; 999-A.
 - c. GE Advanced Materials - Silicones; Contractors SCS1000 or Construction SCS1200.
 - d. May National Associates, Inc.; Sil 100 GC, Sil 100 GP or Sil 100 WF.
 - e. Pecora Corporation; 860.
 - f. Polymeric Systems, Inc.; PSI-601.
 - g. Schnee-Morehead, Inc.; SM5732 Polyglaze.
 - h. Tremco Incorporated; Proglaze or Tremsil 200.

- E. JS-05 - Single-Component, Nonsag, Traffic-Grade, Neutral-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 100/50, for Use T.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Dow Corning Corporation; 790 or NS Parking Structure Sealant.
 - b. May National Associates, Inc.; Bondaflex Sil 728 NS.
 - c. Pecora Corporation; 301 NS or 311 NS.
 - d. Tremco Incorporated; Spectrem 800.

- F. JS-06 - Single-Component, Pourable, Traffic-Grade, Neutral-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade P, Class 100/50, for Use T.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Dow Corning Corporation; 890-SL or SL Parking Structure Sealant.
 - b. May National Associates, Inc.; Bondaflex Sil 728 SG or Sil 728 SL.
 - c. Pecora Corporation; 300 SL or 310 SL.
 - d. Tremco Incorporated; Spectrem 900 SL.

- G. JS-07 - Multicomponent, Nonsag, Neutral-Curing Silicone Joint Sealant: ASTM C 920, Type M, Grade NS, Class 50, for Use NT.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Tremco Incorporated; Spectrem 4TS.

- H. JS-08 - Multicomponent, Pourable, Traffic-Grade, Neutral-Curing Silicone Joint Sealant: ASTM C 920, Type M, Grade P, Class 100/50, for Use T.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Dow Corning Corporation; FC Parking Structure Sealant.
 - b. May National Associates, Inc.; Bondaflex Sil 728 RCS.

- I. JS-09 - Mildew-Resistant, Single-Component, Nonsag, Neutral-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 25, for Use NT.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Pecora Corporation; 898.

- J. JS-10 - Mildew-Resistant, Single-Component, Acid-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 25, for Use NT.

1. Products: Subject to compliance with requirements, provide one of the following:
 - a. BASF Building Systems; Omniplus.
 - b. Dow Corning Corporation; 786 Mildew Resistant.
 - c. GE Advanced Materials - Silicones; Sanitary SCS1700.
 - d. May National Associates, Inc.; Bondaflex Sil 100 WF.
 - e. Tremco Incorporated; Tremsil 200 Sanitary.

2.03 URETHANE JOINT SEALANTS

- A. JS-20 - Single-Component, Nonsag, Urethane Joint Sealant: ASTM C 920, Type S, Grade NS, Class 100/50, for Use NT.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Sika Corporation, Construction Products Division; Sikaflex - 15LM.
 - b. Tremco Incorporated; Vulkem 921, or Dymonic FC.
- B. JS-21 - Single-Component, Nonsag, Urethane Joint Sealant: ASTM C 920, Type S, Grade NS, Class 50, for Use NT.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Pacific Polymers International, Inc.; Elasto-Thane 230 LM Type II.
 - b. Polymeric Systems, Inc.; PSI-901.
- C. JS-22 - Single-Component, Nonsag, Urethane Joint Sealant: ASTM C 920, Type S, Grade NS, Class 25, for Use NT.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. BASF Building Systems; Sonolastic NP1, Sonolastic TX1, or Sonolastic Ultra.
 - b. Bostik, Inc.; Chem-Calk 900, 915, or 916 Textured.
 - c. May National Associates, Inc.; Bondaflex PUR 25, Bondaflex PUR 25 Textured, or Bondaflex PUR 40 FC.
 - d. Pacific Polymers International, Inc.; Elasto-Thane 230 Type II.
 - e. Pecora Corporation; Dynatrol I-XL.
 - f. Polymeric Systems, Inc.; Flexiprene 1000.
 - g. Schnee-Morehead, Inc.; Permathane SM7100, Permathane SM7108, or Permathane SM7110.
 - h. Sika Corporation, Construction Products Division; Sikaflex - 1a.
 - i. Tremco Incorporated; Dymonic or Vulkem 116.
- D. JS-23 - Single-Component, Nonsag, Traffic-Grade, Urethane Joint Sealant: ASTM C 920. Type S, Grade NS, Class 25, for Use T.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. BASF Building Systems; Sonolastic NP1 or Sonolastic Ultra.
 - b. May National Associates, Inc.; Bondaflex PUR 40 FC.
 - c. Pacific Polymers International, Inc.; Elasto-Thane 230 Type II.
 - d. Sika Corporation, Construction Products Division; Sikaflex - 1a.
 - e. Tremco Incorporated; Vulkem 116.
- E. JS-24 - Single-Component, Pourable, Traffic-Grade, Urethane Joint Sealant: ASTM C 920, Type S, Grade P, Class 25, for Use T.

1. Products: Subject to compliance with requirements, provide one of the following:
 - a. BASF Building Systems; Sonolastic SL 1.
 - b. Bostik, Inc.; Chem-Calk 950.
 - c. May National Associates, Inc.; Bondaflex PUR 35 SL.
 - d. Pecora Corporation; Urexpan NR-201.
 - e. Polymeric Systems, Inc.; Flexiprene 952.
 - f. Schnee-Morehead, Inc.; Permathane SM7101.
 - g. Sika Corporation. Construction Products Division; Sikaflex - 1CSL.
 - h. Tremco Incorporated; Vulkem 45.

- F. JS-25 - Multicomponent, Nonsag, Urethane Joint Sealant: ASTM C 920, Type M, Grade NS, Class 50, for Use NT.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Pecora Corporation; Dynatrol II.
 - b. Polymeric Systems, Inc.; PSI-270.
 - c. Tremco Incorporated; Dymeric 240, or Dymeric 240 FC.

- G. JS-26 - Multicomponent, Nonsag, Urethane Joint Sealant: ASTM C 920, Type M, Grade NS, Class 25, for Use NT.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. BASF Building Systems; Sonolastic NP 2.
 - b. Bostik, Inc.; Chem-Calk 500.
 - c. May National Associates, Inc.; Bondaflex PUR 2 NS.
 - d. Pacific Polymers International, Inc.; Elasto-Thane 227 High Shore Type II, Elasto-Thane 227 R Type II, or Elasto-Thane 227 Type II.
 - e. Pecora Corporation; Dynatred.
 - f. Sika Corporation, Construction Products Division; Sikaflex - 2c NS or Sikaflex - 2c EZ Mix.
 - g. Tremco Incorporated; Vulkem 227.

- H. JS-27 - Multicomponent, Nonsag, Traffic-Grade, Urethane Joint Sealant: ASTM C 920, Type M, Grade NS, Class 50, for Use T.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Polymeric Systems, Inc.; PSI-270.
 - b. Tremco Incorporated; Dymeric 240 FC.

- I. JS-28 - Multicomponent, Nonsag, Traffic-Grade, Urethane Joint Sealant: ASTM C 920, Type M, Grade NS, Class 25, for Use T.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. BASF Building Systems; Sonolastic NP 2.
 - b. LymTal International, Inc.; Iso-Flex 885 SG.
 - c. May National Associates, Inc.; Bondaflex PUR 2 NS.
 - d. Pacific Polymers International, Inc.; Elasto-Thane 227 High Shore Type II, or Elasto-Thane 227 Type II.
 - e. Pecora Corporation; Dynatred.
 - f. Sika Corporation, Construction Products Division; Sikaflex - 2c NS or Sikaflex - 2c EZ Mix.

- g. Tremco Incorporated; Vulkem 227.

2.04 LATEX JOINT SEALANTS

- A. JS-50 - Latex Joint Sealant: Acrylic latex or siliconized acrylic latex, ASTM C 834, Type OP, Grade NF.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. BASF Building Systems; Sonolac.
 - b. Bostik, Inc.; Chem-Calk 600.
 - c. May National Associates, Inc.; Bondaflex 600 or Bondaflex Sil-A 700.
 - d. Pecora Corporation; AC-20+.
 - e. Schnee-Morehead, Inc.; SM 8200.
 - f. Tremco Incorporated; Tremflex 834.

2.05 SOLVENT-RELEASE-CURING JOINT SEALANTS

- A. JS-60 - Acrylic-Based Joint Sealant: ASTM C 1311.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Schnee-Morehead, Inc.; Acryl-R Acrylic Sealant.
 - b. Tremco Incorporated; Mono 555.
- B. JS-61 - Butyl-Rubber-Based Joint Sealant: ASTM C 1311.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Bostik, Inc.; Chem-Calk 300.
 - b. Pecora Corporation; BC-158.
 - c. Tremco Incorporated; Tremco Butyl Sealant.

2.06 JOINT SEALANT BACKING

- A. General: Provide sealant backings of material that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.
- B. Cylindrical Sealant Backings: ASTM C 1330, Type indicated below, and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance. Type indicated below except where approved otherwise in writing by joint-sealant manufacturer for joint application indicated:

Location	Exposure	Position	Type
Exterior	Wet	Vertical	C (closed-cell material with a surface skin) B (bicellular material with a surface skin)
		Horizontal	C (closed-cell material with a surface skin) B (bicellular material with a surface skin)
	Dry	Vertical	B (bicellular material with a surface skin)
		Horizontal	B (bicellular material with a surface skin)
Interior	Wet	Vertical	C (closed-cell material with a surface skin) B (bicellular material with a surface skin)
		Horizontal	C (closed-cell material with a surface skin) B (bicellular material with a surface skin)
	Dry	Vertical	O (open-cell material)

Location	Exposure	Position	Type
			B (bicellular material with a surface skin)
		Horizontal	B (bicellular material with a surface skin)

- C. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint. Provide self-adhesive tape where applicable.

2.07 MISCELLANEOUS MATERIALS

- A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.
- B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.
- C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:
1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
 2. Clean porous joint substrate surfaces by brushing, grinding, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:
 - a. Concrete.
 - b. Masonry including brick, CMU, and stone.
 - c. Unglazed surfaces of ceramic tile.
 3. Remove laitance and form-release agents from concrete.
 4. Clean nonporous joint substrate surfaces with chemical cleaners or other means

that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Nonporous joint substrates include the following:

- a. Metal.
 - b. Glass.
 - c. Porcelain enamel.
 - d. Glazed surfaces of ceramic tile.
- B. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.
- C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.03 INSTALLATION OF JOINT SEALANTS

- A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.
- B. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- C. Install sealant backings of kind indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
1. Do not leave gaps between ends of sealant backings.
 2. Do not stretch, twist, puncture, or tear sealant backings.
 3. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.
- D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.
- E. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
1. Place sealants so they directly contact and fully wet joint substrates.
 2. Completely fill recesses in each joint configuration.
 3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
- F. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified in subparagraphs below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
1. Remove excess sealant from surfaces adjacent to joints.
 2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
 3. Joint Profile: Provide the following:

- a. Concave joint profile per Figure 8A in ASTM C 1193, unless otherwise indicated.
 - b. Flush joint profile per Figure 8B in ASTM C 1193, where indicated on Drawings.
 - c. Recessed joint configuration per Figure 8C in ASTM C 1193, of recess depth and at locations indicated on Drawings.
- 1) Use masking tape to protect surfaces adjacent to recessed tooled joints.

3.04 FIELD QUALITY CONTROL

- A. Field-Adhesion Testing: Field test joint-sealant adhesion to joint substrates as follows:
 1. Extent of Testing: Test completed and cured sealant joints as follows:
 - a. Perform 1 test for each 1000 feet of joint length thereafter or 1 test per each floor per elevation.
 2. Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1 in ASTM C 1193 or Method A, Tail Procedure, in ASTM C 1521.
 - a. For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.
 3. Inspect tested joints and report on the following:
 - a. Whether sealants filled joint cavities and are free of voids.
 - b. Whether sealant dimensions and configurations comply with specified requirements.
 - c. Whether sealants in joints connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. Compare these results to determine if adhesion passes sealant manufacturer's field-adhesion hand-pull test criteria.
 4. Record test results in a field-adhesion-test log. Include dates when sealants were installed, names of persons who installed sealants, test dates, test locations, whether joints were primed, adhesion results and percent elongations, sealant fill, sealant configuration, and sealant dimensions.
 5. Repair sealants pulled from test area by applying new sealants following same procedures used originally to seal joints. Ensure that original sealant surfaces are clean and that new sealant contacts original sealant.
- B. Evaluation of Field-Adhesion Test Results: Sealants not evidencing adhesive failure from testing or noncompliance with other indicated requirements will be considered satisfactory. Remove sealants that fail to adhere to joint substrates during testing or to comply with other requirements. Retest failed applications until test results prove sealants comply with indicated requirements.

3.05 CLEANING

- A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint

sealants and of products in which joints occur.

3.06 PROTECTION

- A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

END OF SECTION 07 92 00

SECTION 07 92 13
EXTERIOR JOINT SEALANTS**PART 1 - GENERAL****1.1 SUMMARY**

- A. Furnish labor, materials, tools, equipment, and services for Sealants, as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

- A. Definitions:
 - 1. Caulk and Caulking are synonymous with sealant work.
- B. Paving Joints include joints in floor slabs, sidewalks, steps, ramps and curbs.
- C. Seal joints which would otherwise permit penetration of moisture or air, unless sealant work is specifically required under other section.
- D. Provide sealants as follows:
 - 1. Flashing reglets and retainers.
 - 2. Exterior wall joints.
 - 3. Masonry control joints, and between masonry and other materials.
 - 4. Isolation joints.
 - 5. Joints between paving or sidewalks and building.
 - 6. Joints at penetrations of walls, floors and decks by piping and other services and equipment not requiring firestopping.
 - 7. Perimeters door and window frames, louvers, grilles, etc.
 - 8. Joints between dissimilar materials, to provide visually acceptable closures.
 - 9. Solidly bed thresholds at exterior doors.
 - 10. Other joints where caulking, or sealant is indicated.
 - 11. Joints where Pre-molded Compressible Sealants is indicated.
- E. Related materials specified elsewhere:
 - 1. Interior Joint Sealants: See Section 07 92 16.
 - 2. Firestopping: Specified in Section 07 84 00.

1.3 REFERENCES

- A. American Society for Testing and Materials:
 - 1. ASTM C510 Standard Test Method for Staining and Color Change of Single- or Multicomponent Joint Sealants
 - 2. ASTM C920 Standard Specification for Elastomeric Joint Sealants
 - 3. ASTM C1193 Standard Guide for Use of Joint Sealants

1.4 SUBMITTALS

- A. Shop Drawings:
 - 1. Sealant Schedule with the following information:
 - a. Generally describe locations requiring sealants (i.e. Brick to Aluminum Window).
 - b. List type of sealant and name of product proposed for each location.
 - c. Include a blank Color Column on schedule for selection.
 - d. Architect to complete Color Column upon selection from submitted samples.
- B. Product Data:

1. Performance characteristics and limitations.
 2. Recommended installation.
- C. Samples:
1. Cured sample of each color. Submit with Sealant Schedule.
- D. Contract Closeout Information:
1. Warranty.

1.5 WARRANTY

- A. Provide written warranty that sealant work will remain free of defects for a period of 3 years from Date of Substantial Completion:
1. Failure of water or air tightness constitutes defect.
 2. Loss of adhesion, cohesion or failure to cure constitutes defect.
 3. Remove defective work and materials and replace with new work and materials.
 4. Repair other work damaged as a result of defective sealant work at no additional expense to Owner.
 5. Non- prorated warranty to include labor and material.
 6. Warranty signed by Installer, Contractor, or both.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

- A. Silicone sealants:
1. Base:
 - a. Tremco.
 - b. Dow Corning.
 2. Optional:
 - a. Pecora.
 - b. GE Silicones.
 - c. Sonneborn/ChemRex.
 - d. Bondaflex Technologies.
- B. Polyurethane sealants:
1. Base:
 - a. Tremco.
 2. Optional:
 - a. Pecora.
 - b. Sonneborn/ChemRex.
 - c. Sika.
 - d. Bondaflex Technologies.
- C. Other Sealants:
1. Base: As indicated.

2.2 MATERIALS

- A. General:
1. ASTM C920 Type S or M, Grade-NS, minimum Class 25.
 2. Non-staining sealant complying with ASTM C510.
 3. Where sealant is not exposed to view, use manufacturer's standard color which has best performance.
 4. Use non-sag sealant in vertical joints.
 5. Use self-leveling or non-sag sealant in horizontal joints.
 6. Before use of sealant, investigate its compatibility with surfaces, fillers and other materials in joint system.

- B. Elastomeric Sealants:
1. Refer to Sealant Selection Guide for Base Products.
 2. Comply with VOC limits as required by local laws.
 3. VOC content no greater than 250 g/L.

2.3 PRE-MOLDED COMPRESSIBLE SEALANT

- A. Pre-molded Compressible Sealant (pre-finished):
1. Description: Foam backing: Multiple layers of acrylic-impregnated, expanding foam sealant and closed-cell (EVA) foam.
 2. Weather Facing: Low-modulus silicone with bellows profile.
 3. Movement capability: +/-25 percent movement, 50 percent total.
 4. Material to be sized appropriately for joint widths indicated.
 5. Base Product: ColorSeal by Emseal.
- B. Compressible Backer:
1. Description: Foam backing with multiple layers of acrylic-impregnated, expanding foam sealant and closed-cell (EVA) foam.
 2. Provide behind conventional backer-rod and sealant where indicated.
 3. Provide behind directly-applied liquid sealant where indicated.
 4. Movement capability: +/- 25 percent movement, 50 percent total.
 5. Material to be sized appropriately for joint widths indicated.
 6. Base Product: Backerseal by Emseal.
- C. Accessory Items:
1. Installation Adhesive: As recommended by manufacturer of compressible sealants and backers.
 2. Comply with VOC limits as required by local laws.

2.4 MISCELLANEOUS MATERIALS

- A. Joint cleaner, primer, bond breaker:
1. As recommended by sealant manufacturer.
- B. Backer Rod:
1. Rod stock of polyethylene, polyethylene jacketed polyurethane foam, or other flexible, non-absorbent, non-bituminous material recommended by sealant manufacturer to:
 - a. Control joint depth.
 - b. Break bond of sealant at bottom of joint.
 - c. Provide proper shape of sealant.

PART 3 - EXECUTION

3.1 SEALANT USAGE GUIDELINES

Guide to Sealant Types - EXTERIOR				
Location	Materials	Sealant Type	Base Product	Remarks / Exceptions
General Exterior	Cast in Place Concrete	Multi-part Polyurethane, chemically curing, epoxidized	Tremco Dymeric 240FC	Exception: Use Dymonic where used as bedding sealant for frames, sills, thresholds etc.
	Brick and Concrete Masonry			
	Portland Cement Plaster			
	Hollow Metal Door and Window Perimeters			

Guide to Sealant Types - EXTERIOR					
Location	Materials	Sealant Type	Base Product	Remarks / Exceptions	
	Aluminum Composite Panels (ACM) and Metal Column Covers	Silicone or Silyl Terminated Polyether (STPE)	Tremco Spectrem 1 or Sonolastic 150 VLM	--	
	Joints in materials with high coefficients of linear expansion				
	Weatherseals of Aluminum Window Frames (including perimeter joints)				
	Precast Concrete Panels	Silicone or Silyl Terminated Polyether (STPE)	Tremco Spectrem 1 or Spectrem 3 or Sonolastic 150 VLM	--	
	EIFS Systems				
	Stone Work	Silicone or Silyl Terminated Polyether (STPE)	Tremco Spectrem 3 or Sonolastic 150 VLM	Exception: Pre-test for staining potential per ASTM C1248, with stain-sensitive stone Note: Sonolastic will not stain.	
	General Exterior Glazing	Silicone; Neutral-cure	Tremco Spectrem 2 or Proglaze	Exception: Select alternate silicone sealant types as appropriate for specific glazing application.	
	Butt Glazing and Structural Silicone Joints	Silicone; 1-part, Neutral-cure	Dow Corning 795	--	
	Fabrication of Insulating Glass Units (IGU)	Primary Seal: Polyisobutylene	Select high quality sealants, of basic type listed, as appropriate for specific application.		
		Secondary Seal: Silicone	Dow Corning 982	--	
	Zone dams, shear blocks and other internal component of Aluminum Window Systems	Silicone	Use product which offers optimal adhesion and performance for application.		
	Sheet Metal Gutters, Downspouts, Scuppers, etc	Synthetic Rubber-Resin, elastomeric	Tremco Gutter Sealant	--	
Existing joints where Silicone was previously used	Silicone	Use product which offers optimal adhesion and performance for condition, and which offers suitable color choices for matching.			
Exterior Flatwork	Concrete Paving and Parking Structures	Multi-part Polyurethane	Tremco THC 900 / 901	Exception: Where subject to continual water emersion; use Vulkem 45 or 245	
	Concrete Walks				
	Brick Paving and Walks				
	Stone and Precast Plazas				

General Notes:

1. The above is intended to be an overall guide. Additional conditions and materials may be required. Notify Architect if additional Guidance is required to select unlisted items.
2. Optional sealant products shall offer same number of color choices as the Base Product listed.
3. All of the conditions and materials listed may not apply to subject project.

3.2 EXAMINATION

- A. Environmental Limitations:
 1. Do not proceed with installation of joint sealants under following conditions:
 - a. When ambient and substrate temperature conditions are outside limits permitted by joint sealant manufacturer or are below 5 degC 40 degF.
 - b. When joint substrates are wet.
- B. Joint-Width Conditions:
 1. Do not proceed with installation of joint sealants where joint widths are less than those allowed by joint sealant manufacturer for applications indicated.
- C. Apply only to joints free of material which may inhibit bond.
- D. Apply to cementitious materials only when thoroughly cured and dry.

3.3 PREPARATION

- A. Clean joints and prime as required by sealant manufacturer.
- B. Where finish coating or covering is to be applied to surface (e.g., paint, wall covering, glazed coating), wait until such coating or covering has been applied before installing sealant.
- C. Limit application to surfaces to receive sealants and mask edges of joints to protect adjacent surfaces.

3.4 INSTALLATION

- A. Install sealant backings of kind indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
 1. Do not leave gaps between ends of sealant backings.
 2. Do not stretch, twist, puncture, or tear sealant backings.
 3. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.
- B. Make depth of sealant not more than one-half width of joint, but not less than 6mm 1/4 IN.
- C. Sub-caulk joints without suitable backstop, to proper depth.
- D. Install correctly sized backer rods.
- E. Apply bond breaker as required or recommended by sealant manufacturer.
- F. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.
- G. Make joints water and air tight.
- H. Install sealants using proven techniques that comply with the following and at same time backings are installed:
 1. Place sealants so they directly contact and fully wet joint substrates.
 2. Completely fill recesses in each joint configuration.

3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
- I. Tooling of Non-sag Sealants:
 1. Tool immediately after sealant application and before skinning or curing begins, to form smooth, uniform beads, eliminate air pockets, and ensure contact and adhesion of sealant with sides of joint.
 2. Remove excess sealant adjacent to joints as the Work progresses with cleaning materials approved by manufacturers of joint sealants and of products in which joints occur.
 3. Use tooling agents that are approved by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
 4. Provide concave joint profile per Figure 8A in ASTM C 1193, unless otherwise indicated.
- J. At traffic joints, slightly recess sealant to avoid direct contact with wheeled traffic.

PART 4 - MEASUREMENT

4.1 Measurement – No Separate measurement will be made for Work described in this Section.

PART 5 - PAYMENT

5.1 Payment – Payment for items in this Section will be incidental to the Contract unit cost of the metal bid items.

END OF SECTION

SECTION 08 11 13**HOLLOW METAL DOORS AND FRAMES****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY**A. Section Includes:**

- 1. Standard hollow metal doors and frames.

B. Related Sections:

- 1. Division 04 Section "Unit Masonry" for embedding anchors for hollow metal work into masonry construction.
- 2. Division 08 Section "Door Hardware" for door hardware for hollow metal doors.
- 3. Division 08 glazing sections for lites in hollow metal doors.
- 4. Division 09 Sections "Exterior Painting" and "Interior Painting" for field painting hollow metal doors and frames.
- 5. Division 26 Sections for electrical connections including conduit and wiring for door controls and operators.

1.03 DEFINITIONS

- A. Minimum Thickness: Minimum thickness of base metal without coatings.

- B. Standard Hollow Metal Work: Hollow metal work fabricated according to ANSI/SDI A250.8.

- C. Custom Hollow Metal Work: Hollow metal work fabricated according to ANSI/NAAMM-HMMA 861.

1.04 SUBMITTALS

- A. Product Data: For each type of product.

- 1. Include construction details, material descriptions, core descriptions, fire-resistance ratings, and finishes.

B. LEED Submittals:

- 1. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.

- C. Shop Drawings: Include the following:

- 1. Elevations of each door type.
- 2. Details of doors, including vertical- and horizontal-edge details and metal thicknesses.

3. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
 4. Locations of reinforcement and preparations for hardware.
 5. Details of each different wall opening condition.
 6. Details of anchorages, joints, field splices, and connections.
 7. Details of accessories.
 8. Details of moldings, removable stops, and glazing.
 9. Details of conduit and preparations for power, signal, and control systems.
- D. Samples for Initial Selection: For units with factory-applied color finishes.
- E. Samples for Verification:
1. For each type of exposed finish required, prepared on Samples of not less than 3 by 5 inches .
 2. For "Doors" and "Frames" subparagraphs below, prepare Samples approximately 12 by 12 inches to demonstrate compliance with requirements for quality of materials and construction:
 - a. Doors: Show vertical-edge, top, and bottom construction; core construction; and hinge and other applied hardware reinforcement. Include separate section showing glazing if applicable.
 - b. Frames: Show profile, corner joint, floor and wall anchors, and silencers. Include separate section showing fixed hollow-metal panels and glazing if applicable.
- F. Schedule: Provide a schedule of hollow-metal work prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings. Coordinate with final Door Hardware Schedule.
- G. Product Test Reports: For each type of hollow-metal door and frame assembly, for tests performed by a qualified testing agency.

1.05 QUALITY ASSURANCE

- A. Source Limitations: Obtain hollow metal work from single source from single manufacturer.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver hollow metal work palletized, wrapped, or crated to provide protection during transit and Project-site storage. Do not use nonvented plastic.
1. Provide additional protection to prevent damage to finish of factory-finished units.
- B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.
- C. Store hollow metal work under cover at Project site. Place in stacks of five units maximum in a vertical position with heads up, spaced by blocking, on minimum 4-inch-high wood blocking. Do not store in a manner that traps excess humidity.
1. Provide minimum 1/4-inch space between each stacked door to permit air circulation.

1.07 PROJECT CONDITIONS

- A. Field Measurements: Verify actual dimensions of openings by field measurements

before fabrication.

1.08 COORDINATION

- A. Coordinate installation of anchorages for hollow metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Amweld Building Products, LLC.
 - 2. Benchmark; a division of Therma-Tru Corporation.
 - 3. Ceco Door Products; an Assa Abloy Group company.
 - 4. Curries Company; an Assa Abloy Group company.
 - 5. Deansteel Manufacturing Company, Inc.
 - 6. Firedoor Corporation.
 - 7. Fleming Door Products Ltd.; an Assa Abloy Group company.
 - 8. Habersham Metal Products Company.
 - 9. Kewanee Corporation (The).
 - 10. Mesker Door Inc.
 - 11. Pioneer Industries, Inc.
 - 12. Security Metal Products Corp.
 - 13. Steelcraft; an Ingersoll-Rand company.
 - 14. Windsor Republic Doors.

2.02 MATERIALS

- A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 50 percent.
- B. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B; suitable for exposed applications.
- C. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.
- D. Frame Anchors: ASTM A 591/A 591M, Commercial Steel (CS), 40Z coating designation; mill phosphatized.
 - 1. For anchors built into exterior walls, steel sheet complying with ASTM A 1008/A 1008M or ASTM A 1011/A 1011M, hot-dip galvanized according to ASTM A 153/A 153M, Class B.
- E. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A 153/A 153M.
- F. Powder-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hollow metal frames of type indicated.

- G. Grout: ASTM C 476, except with a maximum slump of 4 inches, as measured according to ASTM C 143/C 143M.
- H. Mineral-Fiber Insulation: ASTM C 665, Type I (blankets without membrane facing); consisting of fibers manufactured from slag or rock wool with 6- to 12-lb/cu. ft. density; with maximum flame-spread and smoke-development indexes of 25 and 50, respectively; passing ASTM E 136 for combustion characteristics.
- I. Glazing: Comply with requirements in Division 08 Section "Glazing."
- J. Bituminous Coating: Cold-applied asphalt mastic, SSPC-Paint 12, compounded for 15-mil dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.
 - 1. VOC Content: 0.25 lb/gal. (30 g/L) or less.
 - 2. Coating shall not contain aromatic compounds and restricted components listed in Division 01 Section "Sustainable Design Requirements" for paints and coatings.

2.03 STANDARD HOLLOW METAL DOORS

- A. General: Provide doors of design indicated, not less than thickness indicated; fabricated with smooth surfaces, without visible joints or seams on exposed faces unless otherwise indicated. Comply with ANSI/SDI A250.8.
 - 1. Design: Flush panel.
 - 2. Core Construction: Manufacturer's standard kraft-paper honeycomb, polystyrene, polyurethane, polyisocyanurate, mineral-board, or vertical steel-stiffener core.
 - a. Thermal-Rated (Insulated) Doors: Where indicated, provide doors fabricated with thermal-resistance value (R-value) of not less than 4.0 deg F x h x sq. ft./Btu when tested according to ASTM C 1363.
 - 1) Locations: Exterior doors
 - 3. Vertical Edges for Single-Acting Doors: Manufacturer's standard.
 - a. Beveled Edge: 1/8 inch in 2 inches.
 - 4. Vertical Edges for Double-Acting Doors: Round vertical edges with 2-1/8-inch radius.
 - 5. Top and Bottom Edges: Closed with flush or inverted 0.042-inch- thick, end closures or channels of same material as face sheets.
 - 6. Tolerances: Comply with SDI 117, "Manufacturing Tolerances for Standard Steel Doors and Frames."
- B. Exterior Doors: Face sheets fabricated from metallic-coated steel sheet. Provide doors complying with requirements indicated below by referencing ANSI/SDI A250.8 for level and model and ANSI/SDI A250.4 for physical performance level:
 - 1. Level 4 and Physical Performance Level A (Maximum Duty), Model 1 (Full Flush.
- C. Interior Doors: Face sheets fabricated from cold-rolled steel sheet. Provide doors complying with requirements indicated below by referencing ANSI/SDI A250.8 for level and model and ANSI/SDI A250.4 for physical performance level:
 - 1. Level 3 and Physical Performance Level A (Extra Heavy Duty), Model 1 (Full

Flush).

- D. Hardware Reinforcement: Fabricate according to ANSI/SDI A250.6 with reinforcing plates from same material as door face sheets.
- E. Fabricate concealed stiffeners and hardware reinforcement from either cold- or hot-rolled steel sheet.

2.04 STANDARD HOLLOW METAL FRAMES

- A. General: Comply with ANSI/SDI A250.8 and with details indicated for type and profile.
- B. Exterior Frames: Fabricated from metallic-coated steel sheet.
 - 1. Fabricate frames with mitered or coped corners.
 - 2. Fabricate frames as full profile welded.
 - 3. Frames for Level 4 Steel Doors: 0.067-inch- thick steel sheet.
- C. Interior Frames: Fabricated from cold-rolled steel sheet unless metallic-coated sheet is indicated.
 - 1. Fabricate frames with mitered or coped corners.
 - 2. Frames for Level 3 Steel Doors: 0.053-inch- thick steel sheet.
 - 3. Frames for Wood Doors: 0.042-inch-thick steel sheet.
 - 4. Frames for Borrowed Lights: Same as adjacent door frame.
 - 5. Fabricate all frames as full profile welded.
- D. Hardware Reinforcement: Fabricate according to ANSI/SDI A250.6 with reinforcement plates from same material as frames.

2.05 FRAME ANCHORS

- A. Jamb Anchors:
 - 1. Masonry Type: Adjustable strap-and-stirrup or T-shaped anchors to suit frame size, not less than 0.042 inch thick, with corrugated or perforated straps not less than 2 inches wide by 10 inches long; or wire anchors not less than 0.177 inch thick.
 - 2. Stud-Wall Type: Designed to engage stud, welded to back of frames; not less than 0.042 inch thick.
- B. Floor Anchors: Formed from same material as frames, not less than 0.042 inch thick, and as follows:
 - 1. Monolithic Concrete Slabs: Clip-type anchors, with two holes to receive fasteners.
 - 2. Separate Topping Concrete Slabs: Adjustable-type anchors with extension clips, allowing not less than 2-inch height adjustment. Terminate bottom of frames at finish floor surface.

2.06 STOPS AND MOLDINGS

- A. Moldings for Glazed Lites in Doors: Minimum 0.032 inch thick, fabricated from same material as door face sheet in which they are installed.
- B. Fixed Frame Moldings: Formed integral with hollow metal frames, a minimum of 5/8 inch high unless otherwise indicated.

- C. Loose Stops for Glazed Lites in Frames: Minimum 0.032 inch thick, fabricated from same material as frames in which they are installed.
- D. Terminated Stops: Where indicated on interior door frames, terminate stops 6 inches above finish floor with a 45-degree angle cut, and close open end of stop with steel sheet closure. Cover opening in extension of frame with welded-steel filler plate, with welds ground smooth and flush with frame.

2.07 ACCESSORIES

- A. Mullions and Transom Bars: Join to adjacent members by welding or rigid mechanical anchors.
- B. Ceiling Struts: Minimum 1/4-inch-thick by 1-inch- wide steel.
- C. Grout Guards: Formed from same material as frames, not less than 0.016 inch thick.

2.08 FABRICATION

- A. Fabricate hollow metal work to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for thickness of metal. Where practical, fit and assemble units in manufacturer's plant. To ensure proper assembly at Project site, clearly identify work that cannot be permanently factory assembled before shipment.
- B. Tolerances: Fabricate hollow metal work to tolerances indicated in SDI 117.
- C. Hollow Metal Doors:
 - 1. Exterior Doors: Provide weep-hole openings in bottom of exterior doors to permit moisture to escape. Seal joints in top edges of doors against water penetration.
 - 2. Glazed Lites: Factory cut openings in doors.
- D. Hollow Metal Frames: Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of same thickness metal as frames.
 - 1. Welded Frames: Weld flush face joints continuously; grind, fill, dress, and make smooth, flush, and invisible.
 - 2. Sidelight Frames: Provide closed tubular members with no visible face seams or joints, fabricated from same material as door frame. Fasten members at crossings and to jambs by butt welding.
 - 3. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
 - 4. Grout Guards: Weld guards to frame at back of hardware mortises in frames to be grouted.
 - 5. Floor Anchors: Weld anchors to bottom of jambs and mullions with at least four spot welds per anchor.
 - 6. Jamb Anchors: Provide number and spacing of anchors as follows:
 - a. Masonry Type: Locate anchors not more than 18 inches from top and bottom of frame. Space anchors not more than 32 inches o.c. and as follows:
 - 1) Two anchors per jamb up to 60 inches high.
 - 2) Three anchors per jamb from 60 to 90 inches high.
 - 3) Four anchors per jamb from 90 to 120 inches high.

-
- 4) Four anchors per jamb plus 1 additional anchor per jamb for each 24 inches or fraction thereof above 120 inches high.
 - b. Stud-Wall Type: Locate anchors not more than 18 inches from top and bottom of frame. Space anchors not more than 32 inches o.c. and as follows:
 - 1) Three anchors per jamb up to 60 inches high.
 - 2) Four anchors per jamb from 60 to 90 inches high.
 - 3) Five anchors per jamb from 90 to 96 inches high.
 - 4) Five anchors per jamb plus 1 additional anchor per jamb for each 24 inches or fraction thereof above 96 inches high.
 - 5) Two anchors per head for frames above 42 inches wide and mounted in metal-stud partitions.
 7. Door Silencers: Except on weather-stripped doors, drill stops to receive door silencers as follows. Keep holes clear during construction.
 - a. Single-Door Frames: Drill stop in strike jamb to receive three door silencers.
 - b. Double-Door Frames: Drill stop in head jamb to receive two door silencers.
 - E. Fabricate concealed stiffeners, edge channels, and hardware reinforcement from either cold- or hot-rolled steel sheet.
 - F. Hardware Preparation: Factory prepare hollow metal work to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping according to the Door Hardware Schedule and templates furnished as specified in Division 08 Section "Door Hardware."
 1. Locate hardware as indicated, or if not indicated, according to ANSI/SDI A250.8.
 2. Reinforce doors and frames to receive nontemplated, mortised and surface-mounted door hardware.
 3. Comply with applicable requirements in ANSI/SDI A250.6 and ANSI/DHI A115 Series specifications for preparation of hollow metal work for hardware.
 4. Coordinate locations of conduit and wiring boxes for electrical connections with Division 26 Sections.
 - G. Stops and Moldings: Provide stops and moldings around glazed lites where indicated. Form corners of stops and moldings with butted or mitered hairline joints.
 1. Single Glazed Lites: Provide fixed stops and moldings welded on secure side of hollow metal work.
 2. Multiple Glazed Lites: Provide fixed and removable stops and moldings so that each glazed lite is capable of being removed independently.
 3. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames.
 4. Provide loose stops and moldings on inside of hollow metal work.
 5. Coordinate rabbet width between fixed and removable stops with type of glazing and type of installation indicated.

2.09 STEEL FINISHES

- A. Prime Finish: Apply manufacturer's standard primer immediately after cleaning and pretreating.
 - 1. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with ANSI/SDI A250.10 acceptance criteria; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for embedded and built-in anchors to verify actual locations before frame installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Remove welded-in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces.
- B. Prior to installation, adjust and securely brace welded hollow metal frames for squareness, alignment, twist, and plumbness to the following tolerances:
 - 1. Squareness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
 - 2. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.
 - 3. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
 - 4. Plumbness: Plus or minus 1/16 inch, measured at jambs on a perpendicular line from head to floor.
- C. Drill and tap doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.

3.03 INSTALLATION

- A. General: Install hollow metal work plumb, rigid, properly aligned, and securely fastened in place; comply with Drawings and manufacturer's written instructions.
- B. Hollow Metal Frames: Install hollow metal frames of size and profile indicated. Comply with ANSI/SDI A250.11.
 - 1. Set frames accurately in position, plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged.

- a. Where frames are fabricated in sections because of shipping or handling limitations, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces.
 - b. Install frames with removable glazing stops located on secure side of opening.
 - c. Install door silencers in frames before grouting.
 - d. Remove temporary braces necessary for installation only after frames have been properly set and secured.
 - e. Check plumbness, squareness, and twist of frames as walls are constructed. Shim as necessary to comply with installation tolerances.
2. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor, and secure with postinstalled expansion anchors.
 - a. Floor anchors may be set with powder-actuated fasteners instead of postinstalled expansion anchors if so indicated and approved on Shop Drawings.
 3. Metal-Stud Partitions: Solidly pack mineral-fiber insulation behind frames.
 4. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with grout.
 5. Ceiling Struts: Extend struts vertically from top of frame at each jamb to overhead structural supports or substrates above frame unless frame is anchored to masonry or to other structural support at each jamb. Bend top of struts to provide flush contact for securing to supporting construction. Provide adjustable wedged or bolted anchorage to frame jamb members.
 6. Installation Tolerances: Adjust hollow metal door frames for squareness, alignment, twist, and plumb to the following tolerances:
 - a. Squareness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
 - b. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.
 - c. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
 - d. Plumbness: Plus or minus 1/16 inch, measured at jambs at floor.
- C. Hollow Metal Doors: Fit hollow metal doors accurately in frames, within clearances specified below. Shim as necessary.
1. Non-Fire-Rated Standard Steel Doors:
 - a. Jambs and Head: 1/8 inch plus or minus 1/16 inch.
 - b. Between Edges of Pairs of Doors: 1/8 inch plus or minus 1/16 inch.
 - c. Between Bottom of Door and Top of Threshold: Maximum 3/8 inch.
 - d. Between Bottom of Door and Top of Finish Floor (No Threshold): Maximum 3/4 inch.
 2. Fire-Rated Doors: Install doors with clearances according to NFPA 80.
- D. Glazing: Comply with installation requirements in Division 08 Section "Glazing" and with hollow metal manufacturer's written instructions.
1. Secure stops with countersunk flat- or oval-head machine screws spaced uniformly not more than 9 inches o.c. and not more than 2 inches o.c. from each corner.

3.04 ADJUSTING AND CLEANING

- A. Final Adjustments: Check and readjust operating hardware items immediately before final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including hollow metal work that is warped, bowed, or otherwise unacceptable.
- B. Remove grout and other bonding material from hollow metal work immediately after installation.
- C. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.
- D. Metallic-Coated Surfaces: Clean abraded areas and repair with galvanizing repair paint according to manufacturer's written instructions.

END OF SECTION 08 11 13

SECTION 08 14 16**FLUSH WOOD DOORS****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY**A. Section Includes:**

1. Solid-core doors with wood-veneer faces.
2. Factory finishing flush wood doors.
3. Factory fitting flush wood doors to frames and factory machining for hardware.

B. Related Sections:

1. Division 08 Section "Glazing" for glass view panels in flush wood doors.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of door. Include details of core and edge construction and trim for openings. Include factory-finishing specifications.

B. LEED Submittals:

1. Product Certificates for Credit MR 5: For products and materials required to comply with requirements for regional materials, certificates indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include statement indicating distance to Project, cost for each regional material, and fraction by weight that is considered regional.
2. Certificates for Credit MR 7: Chain-of-custody certificates indicating that flush wood doors comply with forest certification requirements. Include documentation that manufacturer is certified for chain of custody by an FSC-accredited certification body
3. Product Data for Credit IEQ 4.4: For adhesives and composite wood products, documentation indicating that product contains no urea formaldehyde.

- C. Shop Drawings: Indicate location, size, and hand of each door; elevation of each kind of door; construction details not covered in Product Data; and the following:

1. Dimensions and locations of blocking.
2. Dimensions and locations of mortises and holes for hardware.
3. Dimensions and locations of cutouts.
4. Undercuts.
5. Requirements for veneer matching.
6. Doors to be factory finished and finish requirements.
7. Fire-protection ratings for fire-rated doors.

- D. Samples for Initial Selection: For factory-finished doors.

- E. Samples for Verification:

1. Factory finishes applied to actual door face materials, approximately 8 by 10 inches, for each material and finish.[For each wood species and transparent finish, provide set of three Samples showing typical range of color and grain to be expected in finished Work.]
2. Corner sections of doors, approximately 8 by 10 inches, with door faces and edges representing actual materials to be used.
 - a. Provide Samples for each species of veneer and solid lumber required.
 - b. Finish veneer-faced door Samples with same materials proposed for factory-finished doors.
3. Louver blade and frame sections, 6 inches long, for each material and finish specified.
4. Frames for light openings, 6 inches long, for each material, type, and finish required.

1.04 INFORMATIONAL SUBMITTALS

- A. Sample Warranty: For special warranty.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A qualified manufacturer that is certified for chain of custody by an FSC-accredited certification body.
- B. Source Limitations: Obtain flush wood doors from single manufacturer.
- C. Quality Standard: In addition to requirements specified, comply with WDMA I.S.1-A, "Architectural Wood Flush Doors."
- D. Forest Certification: Provide doors made with cores veneers not less than 70 percent of wood products all wood products obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."
- E. Fire-Rated Wood Doors: Doors complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252 or UL 10B UL 10C.
 1. Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies, provide certification by a qualified testing agency that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.
 2. Temperature-Rise Limit: At vertical exit enclosures and exit passageways, provide doors that have a maximum transmitted temperature end point of not more than 450 deg F above ambient after 30 minutes of standard fire-test exposure.
- F. Preinstallation Conference: Conduct conference at Project site.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Comply with requirements of referenced standard and manufacturer's written instructions.
- B. Package doors individually in plastic bags or cardboard cartons.
- C. Mark each door on top and bottom rail with opening number used on Shop Drawings.

1.07 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install doors until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
- B. Environmental Limitations: Do not deliver or install doors until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and HVAC system is operating and maintaining temperature between 60 and 90 deg F and relative humidity between 17 and 50 percent during the remainder of the construction period.

1.08 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace doors that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Warping (bow, cup, or twist) more than 1/4 inch in a 42-by-84-inch section.
 - b. Telegraphing of core construction in face veneers exceeding 0.01 inch in a 3 inch span.
 - 2. Warranty Period for Solid-Core Interior Doors: Life of installation.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Graham; an Assa Abloy Group company.
 - 2. Marshfield Door Systems, Inc.
 - 3. VT Industries Inc.

2.02 DOOR CONSTRUCTION, GENERAL

- A. Low-Emitting Materials: Provide doors made with adhesives and composite wood products that do not contain urea formaldehyde.
- B. WDMA I.S.1-A Performance Grade: Standard Duty.
- C. Particleboard-Core Doors:
 - 1. Particleboard: Straw-based particleboard complying with ANSI A208.1, Grade LD-2 or M-2, except for density.
- D. Fire-Protection-Rated Doors: Provide core specified or mineral core as needed to provide fire-protection rating indicated.
 - 1. Edge Construction: Provide edge construction with intumescent seals concealed by outer stile. Comply with specified requirements for exposed edges.
 - 2. Pairs: Provide fire-retardant stiles that are listed and labeled for applications

indicated without formed-steel edges and astragals. Provide stiles with concealed intumescent seals. Comply with specified requirements for exposed edges.

3. Pairs: Provide formed-steel edges and astragals with intumescent seals.
 - a. Finish steel edges and astragals with baked enamel.
 - b. Finish steel edges and astragals to match door hardware (locksets or exit devices).

E. Mineral-Core Doors:

1. Core: Noncombustible mineral product complying with requirements of referenced quality standard and testing and inspecting agency for fire-protection rating indicated.
2. Blocking: Provide composite blocking with improved screw-holding capability approved for use in doors of fire-protection ratings indicated as needed to eliminate through-bolting hardware.
3. Edge Construction: At hinge stiles, provide laminated-edge construction with improved screw-holding capability and split resistance. Comply with specified requirements for exposed edges.

2.03 VENEERED-FACED DOORS FOR TRANSPARENT FINISH

A. Interior Solid-Core Doors:

1. Grade: Premium, with Grade A faces.
2. Species: White oak.
3. Cut: Quarter sawn.
4. Match between Veneer Leaves: Book match.
5. Assembly of Veneer Leaves on Door Faces: Balance match.
6. Exposed Vertical Edges: Same species as faces or a compatible species.
7. Core: Particleboard.
8. Construction: Five or seven plies. Stiles and rails are bonded to core, then entire unit abrasive planed before veneering. Five ply faces are bonded to core using a hot press.

2.04 LOUVERS AND LIGHT FRAMES

A. Wood Louvers: Door manufacturer's standard solid-wood louvers unless otherwise indicated.

1. Wood Species: Species compatible with door faces.

B. Metal Louvers:

C. Wood Beads for Light Openings in Wood Doors: Provide manufacturer's standard wood beads as follows unless otherwise indicated.

1. Wood Species: Same species as door faces.
2. Profile: Flush rectangular beads.

D. Wood-Veneered Beads for Light Openings in Fire-Rated Doors: Manufacturer's standard wood-veneered noncombustible beads matching veneer species of door faces and approved for use in doors of fire-protection rating indicated. Include concealed metal glazing clips where required for opening size and fire-protection rating indicated.

1. Metal Frames for Light Openings in Fire-Rated Doors: Manufacturer's standard

frame formed of 0.048-inch-thick, cold-rolled steel sheet; factory primed for paint finish with baked-enamel- or powder-coated finish; and approved for use in doors of fire-protection rating indicated.

2.05 FABRICATION

- A. Factory fit doors to suit frame-opening sizes indicated. Comply with clearance requirements of referenced quality standard for fitting unless otherwise indicated.
 - 1. Comply with requirements in NFPA 80 for fire-rated doors.
- B. Factory machine doors for hardware that is not surface applied. Locate hardware to comply with DHI-WDHS-3. Comply with final hardware schedules, door frame Shop Drawings, DHI A115-W series standards, and hardware templates.
 - 1. Coordinate with hardware mortises in metal frames to verify dimensions and alignment before factory machining.
 - 2. Metal Astragals: Factory machine astragals and formed-steel edges for hardware for pairs of fire-rated doors.
- C. Openings: Cut and trim openings through doors in factory.
 - 1. Light Openings: Trim openings with moldings of material and profile indicated.
 - 2. Glazing: Factory install glazing in doors indicated to be factory finished. Comply with applicable requirements in Division 08 Section "Glazing."
 - 3. Louvers: Factory install louvers in prepared openings.

2.06 FACTORY FINISHING

- A. General: Comply with referenced quality standard for factory finishing. Complete fabrication, including fitting doors for openings and machining for hardware that is not surface applied, before finishing.
 - 1. Finish faces, all four edges, edges of cutouts, and mortises. Stains and fillers may be omitted on bottom edges, edges of cutouts, and mortises.
- B. Finish doors at factory that are indicated to receive transparent finish.
- C. Transparent Finish:
 - 1. Grade: Premium.
 - 2. Finish: WDMA TR-4 conversion varnish or TR-6 catalyzed polyurethane.
 - 3. Sheen: Satin.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine doors and installed door frames before hanging doors.
 - 1. Verify that frames comply with indicated requirements for type, size, location, and swing characteristics and have been installed with level heads and plumb jams.
 - 2. Reject doors with defects.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Hardware: For installation, see Division 08 Section "Door Hardware."
- B. Installation Instructions: Install doors to comply with manufacturer's written instructions and the referenced quality standard, and as indicated.
 - 1. Install fire-rated doors in corresponding fire-rated frames according to NFPA 80.
- C. Factory-Fitted Doors: Align in frames for uniform clearance at each edge.
- D. Factory-Finished Doors: Restore finish before installation if fitting or machining is required at Project site.

3.03 ADJUSTING

- A. Operation: Rehang or replace doors that do not swing or operate freely.
- B. Finished Doors: Replace doors that are damaged or that do not comply with requirements. Doors may be repaired or refinished if work complies with requirements and shows no evidence of repair or refinishing.

3.04 CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

- A. Comply with Waste Management Plan required under Division 01 Section "Construction Waste Management And Disposal."

END OF SECTION 08 14 16

SECTION 08 31 13**ACCESS DOORS AND FRAMES****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. This Section includes the following:
1. Wall access doors and frames.
 2. Ceiling access doors and frames.
- B. Provide access door and frames at locations indicated in the following table:

Installation in Following Building Elements:	Access to Following Equipment:	Access Door and Frame Type	Nominal Size
Interior Non-Fire-Rated Walls	Piping Shut-Off Valves, Concealed Valves, Shock Absorbers, Clean-Outs	Flush Access Doors and Frames with Exposed Trim	12 inches square
	Control Devices		
Interior Non-Fire-Rated Gypsum Board Ceilings	Manual Volume Dampers	Flush Access Doors and Frames with Exposed Trim	18 inches square
	VAV Terminal Units		
	Piping Shut-Off Valves, Concealed Valves, Clean-Outs		
	Control Devices		
Interior Non-Fire-Rated Walls	Fan Coil Units, Duct Access Doors and other equipment requiring servicing	Flush Access Doors and Frames with Exposed Trim	24 inches square
Interior Non-Fire-Rated Gypsum Board Ceilings	Fan Coil Units, Duct Access Doors and other equipment requiring servicing	Flush Access Doors and Frames with Exposed Trim	24 inches square

- C. Related Sections include the following:
1. Division 09 Section "Acoustical Tile Ceilings" and "Linear Wood Ceilings" for access tile in suspended ceilings.

2. Division 22 Section "Plumbing" for connection of floor door drainage couplings to drains.
3. Division 22 Section "HVAC Air Distribution" for heating and air-conditioning duct access doors.

1.03 SUBMITTALS

- A. Product Data: For each type of door and frame indicated. Include construction details relative to materials, individual components and profiles, finishes for access doors and frames. Include percentage of pre-consumer and post-consumer recycled content. Include percentage of materials extracted, processed and manufactured regionally.
- B. Shop Drawings: Show fabrication and installation details of customized doors and frames. Include plans, elevations, sections, details, and attachments to other Work.
- C. Schedule: Provide complete door and frame schedule, including types, general locations, sizes, construction details, latching or locking provisions, and other data pertinent to installation.

1.04 QUALITY ASSURANCE

- A. Source Limitations: Obtain doors and frames through one source from a single manufacturer.
- B. Size Variations: Obtain Architect's acceptance of manufacturer's standard-size units, which may vary slightly from sizes indicated.

1.05 COORDINATION

- A. Verification: Determine specific locations and sizes for access doors needed to gain access to concealed equipment, and indicate on schedule specified in "Submittals" Article.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
- B. Hot-Rolled Steel Sheets: ASTM A 569/A 569M, Commercial Steel (CS), Type B; free of scale, pitting, and surface defects; pickled and oiled; with minimum thickness indicated representing specified nominal thickness according to ASTM A 568/A 568M.
- C. Cold-Rolled Steel Sheets: ASTM A 366/A 366M, Commercial Steel (CS), or ASTM A 620/A 620M, Drawing Steel (DS), Type B; stretcher-leveled standard of flatness; with minimum thickness indicated representing specified nominal thickness according to ASTM A 568/A 568M. Electrolytic zinc-coated steel sheet, complying with ASTM A 591/A 591M, Class C coating, may be substituted at fabricator's option.

- D. Electrolytic Zinc-Coated Steel Sheet: ASTM A 591/A 591M, Commercial Steel (CS), with Class C coating and phosphate treatment to prepare surface for painting; with minimum thickness indicated representing specified nominal thickness according to ASTM A 568/A 568M for uncoated base metal.
- E. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B, with A60 zinc-iron-alloy (galvannealed) coating or G60 mill-phosphatized zinc coating; stretcher-leveled standard of flatness; with minimum thickness indicated representing specified thickness according to ASTM A 924/A 924M.

2.02 PAINT

- A. Shop Primer for Ferrous Metal: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with performance requirements in FS TT-P-664; selected for good resistance to normal atmospheric corrosion, compatibility with finish paint systems indicated, and capability to provide a sound foundation for field-applied topcoats despite prolonged exposure.
- B. Shop Primer for Metallic-Coated Steel: Organic zinc-rich primer complying with SSPC-Paint 20 and compatible with topcoat.
- C. Galvanizing Repair Paint: High-zinc-dust-content paint for regalvanizing welds in steel, complying with SSPC-Paint 20.

2.03 ACCESS DOORS AND FRAMES

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Acudor Products, Inc.
 - 2. Bar-Co, Inc. Div.; Alfab, Inc.
 - 3. Cesco Products.
 - 4. Jensen Industries.
 - 5. J. L. Industries, Inc.
 - 6. Karp Associates, Inc.
 - 7. Larsen's Manufacturing Company.
 - 8. MIFAB Manufacturing, Inc.
 - 9. Milcor Limited Partnership.
 - 10. Nystrom Building Products Co.
- B. Flush Access Doors and Frames with Exposed Trim: Fabricated from metallic-coated steel sheet.
 - 1. Locations: See Table in Part 1 Article "Summary."
 - 2. Door: Minimum 0.060-inch- thick sheet metal, set flush with exposed face flange of frame.
 - 3. Frame: Minimum 0.060-inch- thick sheet metal with 1-inch- to 1-1/4-inch- wide, surface-mounted trim.
 - 4. Hinges: Either spring-loaded concealed pin type and continuous piano hinge.
 - 5. Latch: Screwdriver-operated cam latch.

2.04 FABRICATION

- A. General: Provide access door assemblies manufactured as integral units ready for installation.
- B. Metal Surfaces: For metal surfaces exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.
- C. Steel Doors and Frames: Grind exposed welds smooth and flush with adjacent surfaces. Furnish attachment devices and fasteners of type required to secure access panels to types of supports indicated.
 - 1. Exposed Flanges: Nominal 1 to 1-1/2 inches wide around perimeter of frame.
 - 2. Provide mounting holes in frames to attach frames to metal framing in drywall construction and to attach masonry anchors in masonry construction. Furnish adjustable metal masonry anchors.
- D. Latching Mechanisms: Furnish number required to hold doors in flush, smooth plane when closed.

2.05 FINISHES, GENERAL

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Finish metal fabrications after assembly.

2.06 METALLIC-COATED STEEL FINISHES

- A. Galvanizing of Steel Shapes and Plates: Hot-dip galvanize items indicated to comply with applicable standard listed below:
 - 1. ASTM A 123/A 123M, for galvanizing steel and iron products.
 - 2. ASTM A 153/A 153M, for galvanizing steel and iron hardware.
- B. Surface Preparation: Clean surfaces with nonpetroleum solvent so surfaces are free of oil and other contaminants. For galvanized surfaces, apply, after cleaning, a conversion coating suited to the organic coating to be applied over it. For metallic-coated surfaces, clean welds, mechanical connections, and abraded areas, and apply galvanizing repair paint specified below to comply with ASTM A 780.
 - 1. Galvanizing Repair Paint: High-zinc-dust-content paint for regalvanizing welds in steel, complying with SSPC-Paint 20.
- C. Factory Priming for Field-Painted Finish: Apply shop primer immediately after cleaning and pretreating.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Advise installers of other work about specific requirements relating to access door installation, including sizes of openings to receive access door and frame, as well as locations of supports, inserts, and anchoring devices.

3.02 INSTALLATION

- A. Comply with manufacturer's written instructions for installing access doors and frames.
- B. Set frames accurately in position and attach securely to supports with plane of face panels aligned with adjacent finish surfaces.
- C. Install flush with adjacent finish surfaces.

3.03 ADJUSTING AND CLEANING

- A. Adjust doors and hardware after installation for proper operation.
- B. Remove and replace doors and frames that are warped, bowed, or otherwise damaged.

END OF SECTION 08 31 13

SECTION 08 32 21**SLIDING GLASS DOOR TRACK****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. This Section includes sliding glass door track set into counter door framing for reception window.
- B. Related Sections: The following Sections contain requirements that may relate to this Section:
 - 1. Division 8 Section "Glazing" for glass panels.

1.03 SUBMITTALS

- A. Product Data: For all products specified. Include dimensions of individual components, profiles, and finishes. Provide installation details, operating instructions, and maintenance information.

1.04 DELIVERY, STORAGE AND HANDLING

- A. Package loose components for field installation of glass specified in Division 9 Section "Glazing."

PART 2 - PRODUCTS**2.01 SLIDING GLASS DOOR TRACK**

- A. Track Assembly: Provide ball bearing zinc-plated steel track assembly for 1/4-inch glass doors. Include upper channel, side channels, shoe, ball-bearing carriers and lower double track.
 - 1. Basis of Design Manufacturer and Product: Knape & Vogt Mfg. Co.; P992 ZC Assembly or comparable product by another manufacturer, as approved by Architect.
- B. Door Pulls: Provide one aluminum door pull for each sliding glass panel.
 - 1. Basis of Design Manufacturer and Product: Knape & Vogt Mfg. Co.; #822 Alum or comparable product by another manufacturer, as approved by Architect.
- C. Ratchet Locks: Provide one chrome look ratchet lock for each sliding glass door assembly. Include 2 keys for each lock.

1. Basis of Design Manufacturer and Product: Knape & Vogt Mfg. Co.: #962 CHR or comparable product by another manufacturer, as approved by Architect.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. General: Install glass into track in accordance with track manufacturer written installation instructions.
- B. Installation in Metal Frames: Permanently mount track and channels to metal frame head and sill. Center track and channels on centerline of adjoining partitions walls.
- C. Installation in Rough Wall Openings: Permanently mount track and channels to header and sill or counter. Center track and channels on centerline of adjoining partitions walls. Package loose components for field installation of glass specified in Division 9 Section "Glazing."

3.02 TESTING AND ADJUSTING

- A. Lubricate bearings and sliding parts; adjust doors to operate easily, free from warp, twist, or distortion entire perimeter.

END OF SECTION 08 32 21

SECTION 08 33 23**EXTERIOR OVERHEAD COILING DOORS****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section Includes:
 - 1. Fire-rated, coiling steel doors.
- B. Related Requirements:
 - 1. Section 05 50 10 "Miscellaneous Metal Fabrications" for miscellaneous steel supports.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type and size of overhead coiling door and accessory.
 - 1. Include construction details, material descriptions, dimensions of individual components, profiles for slats, and finishes.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished accessories.
 - 3. Include description of automatic closing device and testing and resetting instructions.
- B. Shop Drawings: For each installation and for special components not dimensioned or detailed in manufacturer's product data.
 - 1. Include plans, elevations, sections, and mounting details.
 - 2. Include details of equipment assemblies, and indicate dimensions, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Include points of attachment and their corresponding static and dynamic loads imposed on structure.
 - 4. For exterior components, include details of provisions for assembly expansion and contraction and for excluding and draining moisture to the exterior.
 - 5. Show locations of controls, locking devices, detectors or replaceable fusible links, and other accessories.
 - 6. Include diagrams for power, signal, and control wiring.
- C. Samples for Initial Selection: Manufacturer's finish charts showing full range of colors and textures available for units with factory-applied finishes.
 - 1. Include similar Samples of accessories involving color selection.
- D. Samples for Verification: For each type of exposed finish on the following components, in manufacturer's standard sizes:
 - 1. Curtain slats.

2. Bottom bar with sensor edge.
3. Guides.
4. Brackets.
5. Hood.
6. Locking device(s).
7. Include similar Samples of accessories involving color selection.

1.04 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Oversize Construction Certification: For door assemblies required to be fire-rated and that exceed size limitations of labeled assemblies.

1.05 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For overhead coiling doors to include in maintenance manuals.

1.06 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer for both installation and maintenance of units required for this Project.
 1. Maintenance Proximity: Not more than two hours' normal travel time from Installer's place of business to Project site.
- B. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at as close to neutral pressure as possible according to [NFPA 252] [or] [UL 10B].
 1. Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies, provide certification by a qualified testing agency that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.
 2. Temperature-Rise Limit: Where indicated, provide doors that have a maximum transmitted temperature end point of not more than 450 deg F above ambient after 30 minutes of standard fire-test exposure.
 3. Smoke Control: Where indicated, provide doors that are listed and labeled with the letter "S" on the fire-rating label by a qualified testing agency for smoke- and draft-control based on testing according to UL 1784; with maximum air-leakage rate of 3.0 cfm/sq. ft. of door opening at 0.10-inch wg for both ambient and elevated temperature tests.
- C. Regulatory Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines.

PART 2 - PRODUCTS

2.01 MANUFACTURERS, GENERAL

- A. Source Limitations: Obtain overhead coiling doors from single source from single manufacturer.
 1. Obtain operators and controls from overhead coiling door manufacturer.

2.02 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design overhead coiling doors, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Structural Performance, Exterior Doors: Exterior overhead coiling doors shall withstand the wind loads, the effects of gravity loads, and loads and stresses within limits and under conditions indicated according to SEI/ASCE 7.
 - 1. Wind Loads: 35 mph as indicated on Drawings.
 - 2. Deflection Limits: Design overhead coiling doors to withstand design wind load without evidencing permanent deformation or disengagement of door components.
- C. Operability under Wind Load: Design overhead coiling doors to remain operable under design wind load, acting inward and outward.
- D. Seismic Performance: Overhead coiling doors shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified"
 - 2. Seismic Component Importance Factor: 1.5.
- E. Operation Cycles: Provide overhead coiling door components and operators capable of operating for not less than number of cycles indicated for each door. One operation cycle is complete when a door is opened from the closed position to the fully open position and returned to the closed position.

2.03 FIRE-RATED DOOR ASSEMBLY

- A. Fire-Rated Insulated Service Door: Overhead fire-rated coiling door formed with curtain of interlocking metal slats.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide FireStar 700 Series door by Wayne-Dalton Corporation or an approved comparable product by one of the following:
 - a. C.H.I. Overhead Doors.
 - b. Clipay Building Products.
 - c. Cookson Company.
 - d. Cornell Iron Works, Inc.
 - e. McKeon Rolling Steel Door Company, Inc.
 - f. Raynor.
- B. Operation Cycles: Door components and operators capable of operating for not less than 20,000. One operation cycle is complete when a door is opened from the closed position to the fully open position and returned to the closed position.
 - 1. Include tamperproof cycle counter.
- C. Fire Rating: 3 hours with temperature-rise limit and with smoke control.
- D. Air Infiltration: Maximum rate of 0.08 cfm/sq. ft. at 15 and 25 mph when tested according to ASTM E 283.

- E. Curtain R-Value: 5.0 deg F x h x sq. ft./Btu.
- F. Door Curtain Material: Galvanized steel.
- G. Door Curtain Slats: Curved profile slats of 2-5/8-inch center-to-center height.
 - 1. Insulated-Slat Interior Facing: Metal.
- H. Curtain Jamb Guides: Galvanized steel with exposed finish matching curtain slats.
- I. Hood: Galvanized steel.
 - 1. Shape: As shown on Drawings.
 - 2. Mounting: As shown on Drawings.
- J. Locking Devices: Equip door with slide bolt for padlock and chain lock keeper.
- K. Electric Door Operator:
 - 1. Usage Classification: Heavy duty, 25 or more cycles per hour and over 90 cycles per day
 - 2. Operator Location: As shown on Drawings.
 - 3. Safety: Listed according to UL 325 by a qualified testing agency for commercial or industrial use; moving parts of operator enclosed or guarded if exposed and mounted at 8 feet or lower.
 - 4. Motor Exposure: Exterior, wet, and humid.
 - 5. Emergency Manual Operation: Chain type.
 - 6. Obstruction Detection Device: Automatic photoelectric sensor.
 - 7. Control Station(s): Where shown on Drawings
 - 8. Other Equipment: [Audible and visual signals] [Portable radio-control system].
- L. Curtain Accessories: Equip door with smoke seals, automatic closing device, push/pull handles.
- M. Door Finish:
 - 1. Powder-Coated Finish: Color matching Architect's sample.
 - 2. Interior Curtain-Slat Facing: Finish as selected by Architect from manufacturer's full range.

2.04 MATERIALS, GENERAL

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.05 DOOR CURTAIN MATERIALS AND CONSTRUCTION

- A. Door Curtains: Fabricate overhead coiling-door curtain of interlocking metal slats, designed to withstand wind loading indicated, in a continuous length for width of door without splices. Unless otherwise indicated, provide slats of thickness and mechanical properties recommended by door manufacturer for performance, size, and type of door indicated, and as follows:
 - 1. Steel Door Curtain Slats: Zinc-coated (galvanized), cold-rolled structural steel sheet; complying with ASTM A 653/A 653M, with G90 zinc coating; nominal sheet thickness (coated) of 0.028 inch; and as required.

2. Insulation: Fill slats for insulated doors with manufacturer's standard thermal insulation complying with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, according to ASTM E 84 or UL 723. Enclose insulation completely within slat faces.
 3. Metal Interior Curtain-Slat Facing: Match metal of exterior curtain-slat face, with minimum steel thickness of 0.010 inch.
- B. Curtain Jamb Guides: Manufacturer's standard angles or channels and angles of same material and finish as curtain slats unless otherwise indicated, with sufficient depth and strength to retain curtain, to allow curtain to operate smoothly, and to withstand loading. Slot bolt holes for guide adjustment. Provide removable stops on guides to prevent overtravel of curtain, and a continuous bar for holding windlocks.

2.06 HOODS

- A. General: Form sheet metal hood to entirely enclose coiled curtain and operating mechanism at opening head. Contour to fit end brackets to which hood is attached. Roll and reinforce top and bottom edges for stiffness. Form closed ends for surface-mounted hoods and fascia for any portion of between-jamb mounting that projects beyond wall face. Equip hood with intermediate support brackets as required to prevent sagging.
1. Galvanized Steel: Nominal 0.028-inch- thick, hot-dip galvanized steel sheet with G90 zinc coating, complying with ASTM A 653/A 653M.
 2. Include automatic drop baffle on fire-rated doors to guard against passage of smoke or flame.
 3. Exterior-Mounted Doors: Fabricate hood to act as weather protection and with a perimeter sealant-joint-bead profile for applying joint sealant.

2.07 LOCKING DEVICES

- A. Slide Bolt: Fabricate with side-locking bolts to engage through slots in tracks for locking by padlock, located on both left and right jamb sides, operable from coil side.
- B. Locking Device Assembly: Fabricate with cylinder lock, spring-loaded dead bolt, operating handle, cam plate, and adjustable locking bars to engage through slots in tracks.
1. Lock Cylinders: Cylinders specified in Section 08 71 00 "Door Hardware.
 2. Keys: Three for each cylinder.
- C. Chain Lock Keeper: Suitable for padlock.
- D. Safety Interlock Switch: Equip power-operated doors with safety interlock switch to disengage power supply when door is locked.

2.08 CURTAIN ACCESSORIES

- A. Smoke Seals: Equip each fire-rated door with replaceable smoke-seal perimeter gaskets or brushes for smoke and draft control as required for door listing and labeling by a qualified testing agency.
- B. Weatherseals for Exterior Doors: Equip each exterior door with weather-stripping gaskets fitted to entire exterior perimeter of door for a weather-resistant installation unless otherwise indicated.
1. At door head, use 1/8-inch- thick, replaceable, continuous-sheet baffle secured to inside of hood or field- installed on the header.

2. At door jambs, use replaceable, adjustable, continuous, flexible, 1/8-inch- thick seals of flexible vinyl, rubber, or neoprene.
- C. Astragal for Interior Doors: Equip each door bottom bar with a replaceable, adjustable, continuous, compressible gasket of flexible vinyl, rubber, or neoprene as a cushion bumper.
 - D. Push/Pull Handles: Equip each push-up-operated or emergency-operated door with lifting handles on each side of door, finished to match door.
 - E. Pull-Down Strap: Provide pull-down straps for doors more than 84 inches high.
 - F. Automatic-Closing Device for Fire-Rated Doors: Equip each fire-rated door with an automatic-closing device or holder-release mechanism and governor unit complying with NFPA 80 and an easily tested and reset release mechanism. Release mechanism for motor- operated doors shall allow testing without mechanical release of the door. Automatic-closing device shall be designed for activation by the following:
 1. Replaceable fusible links with temperature rise and melting point of 165 deg F interconnected and mounted on both sides of door opening.
 2. Manufacturer's standard UL-labeled smoke detector and door-holder-release devices.
 3. Manufacturer's standard UL-labeled heat detector and door-holder-release devices.
 4. Building fire-detection, smoke-detection, and -alarm systems.

2.09 COUNTERBALANCING MECHANISM

- A. General: Counterbalance doors by means of manufacturer's standard mechanism with an adjustable-tension, steel helical torsion spring mounted around a steel shaft and contained in a spring barrel connected to top of curtain with barrel rings. Use grease-sealed bearings or self-lubricating graphite bearings for rotating members.
- B. Counterbalance Barrel: Fabricate spring barrel of manufacturer's standard hot-formed, structural-quality, seamless or welded carbon-steel pipe, of sufficient diameter and wall thickness to support rolled-up curtain without distortion of slats and to limit barrel deflection to not more than 0.03 in./ft. of span under full load.
- C. Counterbalance Spring: One or more oil-tempered, heat-treated steel helical torsion springs. Size springs to counterbalance weight of curtain, with uniform adjustment accessible from outside barrel. Secure ends of springs to barrel and shaft with cast-steel barrel plugs.
 1. Fire-Rated Doors: Equip with auxiliary counterbalance spring and prevent tension release from main counterbalance spring when automatic closing device operates.
- D. Torsion Rod for Counterbalance Shaft: Fabricate of manufacturer's standard cold-rolled steel, sized to hold fixed spring ends and carry torsional load.
- E. Brackets: Manufacturer's standard mounting brackets of either cast iron or cold-rolled steel plate.

2.10 ELECTRIC DOOR OPERATORS

- A. General: Electric door operator assembly of size and capacity recommended and provided by door manufacturer for door and operation-cycles requirement specified,

with electric motor and factory-prewired motor controls, starter, gear-reduction unit, solenoid-operated brake, clutch, control stations, control devices, integral gearing for locking door, and accessories required for proper operation.

1. Comply with NFPA 70.
 2. Control equipment complying with NEMA ICS 1, NEMA ICS 2, and NEMA ICS 6, with NFPA 70 Class 2 control circuit, maximum 24-V ac or dc.
- B. Usage Classification: Electric operator and components capable of operating for not less than number of cycles per hour indicated for each door.
- C. Door Operator Location(s): Operator location indicated for each door.
1. Top-of-Hood Mounted: Operator is mounted to the right or left door head plate with the operator on top of the door-hood assembly and connected to the door drive shaft with drive chain and sprockets. Headroom is required for this type of mounting.
 2. Front-of-Hood Mounted: Operator is mounted to the right or left door head plate with the operator on coil side of the door-hood assembly and connected to the door drive shaft with drive chain and sprockets. Front clearance is required for this type of mounting.
 3. Wall Mounted: Operator is mounted to the inside front wall on the left or right side of door and connected to door drive shaft with drive chain and sprockets. Side room is required for this type of mounting. Wall mounted operator can also be mounted above or below shaft; if above shaft, headroom is required.
 4. Bench Mounted: Operator is mounted to the right or left door head plate and connected to the door drive shaft with drive chain and sprockets. Side room is required for this type of mounting.
 5. Through-Wall Mounted: Operator is mounted on other side of wall from coil side of door.
- D. Motors: Reversible-type motor for motor exposure indicated.
1. Electrical Characteristics:
 - a. Phase: Single phase Polyphase.
 - b. Volts: 115 208 230 460 Insert value V.
 - c. Hertz: 60.
 2. Motor Size: Minimum size as indicated. If not indicated, large enough to start, accelerate, and operate door in either direction from any position, at a speed not less than 8 in./sec. and not more than 12 in./sec., without exceeding nameplate ratings or service factor.
 3. Operating Controls, Controllers, Disconnect Switches, Wiring Devices, and Wiring: Manufacturer's standard unless otherwise indicated.
 4. Coordinate wiring requirements and electrical characteristics of motors and other electrical devices with building electrical system and each location where installed.
- E. Limit Switches: Equip each motorized door with adjustable switches interlocked with motor controls and set to automatically stop door at fully opened and fully closed positions.
- F. Obstruction Detection Devices: External entrapment protection consisting of indicated automatic safety sensor capable of protecting full width of door opening. For fire-rated doors, activation delays closing.
1. Photoelectric Sensor: Manufacturer's standard system designed to detect an

obstruction in door opening without contact between door and obstruction.

- a. Self-Monitoring Type: Designed to interface with door operator control circuit to detect damage to or disconnection of sensing device. When self-monitoring feature is activated, door closes only with sustained or constant pressure on close button.
- G. Control Station: Three-button control station in fixed location with momentary-contact push-button controls labeled "Open" and "Stop" and sustained- or constant-pressure push-button control labeled "Close."
 1. Interior-Mounted Units: Full-guarded, surface-mounted, heavy-duty type, with general-purpose NEMA ICS 6, Type 1 enclosure.
 2. Exterior-Mounted Units: Full-guarded, standard-duty, surface-mounted, weatherproof type, NEMA ICS 6, Type 4 enclosure, key operated.
- H. Emergency Manual Operation: Equip each electrically powered door with capability for emergency manual operation. Design manual mechanism so required force for door operation does not exceed 25 lbf.
- I. Emergency Operation Disconnect Device: Equip operator with hand-operated disconnect mechanism for automatically engaging manual operator and releasing brake for emergency manual operation while disconnecting motor without affecting timing of limit switch. Mount mechanism so it is accessible from floor level. Include interlock device to automatically prevent motor from operating when emergency operator is engaged.
- J. Motor Removal: Design operator so motor may be removed without disturbing limit-switch adjustment and without affecting emergency manual operation.
- K. Audible and Visual Signals: Audible alarm and visual indicator lights in compliance with regulatory requirements for accessibility.

2.11 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM/NOMMA's "Metal Finishes Manual for Architectural and Metal Products (AMP 500-06)" for recommendations for applying and designating finishes.
- B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.12 STEEL AND GALVANIZED-STEEL FINISHES

- A. Powder-Coat Finish: Manufacturer's standard baked-on finish consisting of prime coat and thermosetting topcoat. Comply with coating manufacturer's written instructions for cleaning, pretreatment, application, and minimum dry film thickness.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates areas and conditions, with Installer present, for compliance with requirements for substrate construction and other conditions affecting performance of the Work.

- B. Examine locations of electrical connections.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install overhead coiling doors and operating equipment complete with necessary hardware, anchors, inserts, hangers, and equipment supports; according to manufacturer's written instructions and as specified.
- B. Install overhead coiling doors, hoods, controls, and operators at the mounting locations indicated for each door.
- C. Accessibility: Install overhead coiling doors, switches, and controls along accessible routes in compliance with regulatory requirements for accessibility.
- D. Fire-Rated Doors: Install according to NFPA 80.
- E. Smoke-Control Doors: Install according to NFPA 80 and NFPA 105.
- F. Power-Operated Doors: Install according to UL 325.

3.03 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
 - 1. Perform installation and startup checks according to manufacturer's written instructions.
 - 2. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.
 - 3. Test door closing when activated by detector or alarm-connected fire-release system. Reset door-closing mechanism after successful test.

3.04 ADJUSTING

- A. Adjust hardware and moving parts to function smoothly so that doors operate easily, free of warp, twist, or distortion.
 - 1. Adjust exterior doors and components to be weather-resistant.
- B. Lubricate bearings and sliding parts as recommended by manufacturer.
- C. Adjust seals to provide tight fit around entire perimeter.

3.05 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain overhead coiling doors.

END OF SECTION 08 33 23

SECTION 08 33 25**OVERHEAD COILING COUNTER DOORS****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

- B. Section Includes manually operated counter doors.
- C. Related Sections:
 - 1. Division 12 Section "Stainless Steel Countertops."

1.02 PERFORMANCE REQUIREMENTS

- A. Operation Cycles: Provide overhead coiling door components and operators capable of operating for not less than number of cycles indicated for each door. One operation cycle is complete when a door is opened from the closed position to the fully open position and returned to the closed position.

1.03 SUBMITTALS

- A. Product Data: For each type and size of overhead coiling door and accessory. Include the following:
 - 1. Construction details, material descriptions, dimensions of individual components, profiles for slats, and finishes.
- B. Shop Drawings: For each installation and for special components not dimensioned or detailed in manufacturer's product data. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
- C. Samples for Initial Selection: Manufacturer's finish charts showing full range of colors and textures available for units with factory-applied finishes.
 - 1. Include similar Samples of accessories involving color selection.
- D. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below.
 - 1. Curtain Slats: 12 inches long.
- E. Qualification Data: For qualified Installer.
- F. Maintenance Data: For overhead coiling doors to include in maintenance manuals.
- G. LEED Submittals:

1. Product Data for Credit MR 4.1 and Credit MR 4.2: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
 - a. Include statement indicating costs for each product having recycled content.

1.04 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for both installation and maintenance of units required for this Project.
- B. Source Limitations: Obtain overhead coiling doors from single source from single manufacturer.

PART 2 - PRODUCTS

2.01 DOOR CURTAIN MATERIALS AND CONSTRUCTION

- A. Door Curtains: Fabricate overhead coiling-door curtain of interlocking metal slats, in a continuous length for width of door without splices. Unless otherwise indicated, provide slats of thickness and mechanical properties recommended by door manufacturer for performance, size, and type of door indicated, and as follows:
 1. Steel Door Curtain Slats: Zinc-coated (galvanized), cold-rolled structural steel sheet; complying with ASTM A 653/A 653M, with G90 zinc coating; nominal sheet thickness (coated) of 0.028 inch and as required to meet requirements.
- B. Endlocks for Counter Doors: Manufacturer's standard locks on not less than alternate curtain slats for curtain alignment and resistance against lateral movement.
- C. Bottom Bar for Counter Doors: Manufacturer's standard continuous channel or tubular shape, fabricated from manufacturer's standard hot-dip galvanized steel to match curtain slats and finish.
- D. Astragal for Interior Doors: Equip each door bottom bar with a replaceable, adjustable, continuous, compressible gasket of flexible vinyl, rubber, or neoprene as a cushion bumper.
- E. Curtain Jamb Guides: Manufacturer's standard angles or channels and angles of same material and finish as curtain slats unless otherwise indicated, with sufficient depth and strength to retain curtain, to allow curtain to operate smoothly, and to withstand loading. Slot bolt holes for guide adjustment. Provide removable stops on guides to prevent overtravel of curtain.
- F. Recycled Content of Steel Products: Provide products with an average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent. the following:
 1. Steel Curtain Material, Structural Steel Guides and Bottom Bar Angle: 50 percent.

2.02 HOOD

- A. General: Form sheet metal hood to entirely enclose coiled curtain and operating mechanism at opening head. Contour to fit end brackets to which hood is attached. Roll and reinforce top and bottom edges for stiffness. Form closed ends for surface-

mounted hoods and fascia for any portion of between-jamb mounting that projects beyond wall face. Equip hood with intermediate support brackets as required to prevent sagging.

1. Galvanized Steel: Nominal 0.028-inch- thick, hot-dip galvanized steel sheet with G90 zinc coating, complying with ASTM A 653/A 653M.

B. Recycled Content of Steel Products: Provide products with an average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than 50 percent.

2.03 LOCKING DEVICES

A. Lockset: Cylinder lock as specified in Section 08 71 00 "Door Hardware."

2.04 COUNTERBALANCING MECHANISM

A. General: Counterbalance doors by means of manufacturer's standard mechanism with an adjustable-tension, steel helical torsion spring mounted around a steel shaft and contained in a spring barrel connected to top of curtain with barrel rings. Use grease-sealed bearings or self-lubricating graphite bearings for rotating members.

B. Counterbalance Barrel: Fabricate spring barrel of manufacturer's standard hot-formed, structural-quality, welded or seamless carbon-steel pipe, of sufficient diameter and wall thickness to support rolled-up curtain without distortion of slats and to limit barrel deflection to not more than 0.03 in./ft. of span under full load.

C. Spring Balance: One or more oil-tempered, heat-treated steel helical torsion springs. Size springs to counterbalance weight of curtain, with uniform adjustment accessible from outside barrel. Secure ends of springs to barrel and shaft with cast-steel barrel plugs.

D. Torsion Rod for Counterbalance Shaft: Fabricate of manufacturer's standard cold-rolled steel, sized to hold fixed spring ends and carry torsional load.

E. Brackets: Manufacturer's standard mounting brackets of either cast iron or cold-rolled steel plate.

F. Recycled Content of Steel Products: Provide products with an average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than the following:

1. General Steel Components in Shafts and Brackets: 50 percent.

2.05 MANUAL DOOR OPERATORS

A. Chain-Hoist Operator: Consisting of endless steel hand chain, chain-pocket wheel and guard, and gear-reduction unit with a maximum 25 lbf force for door operation. Provide alloy-steel hand chain with chain holder secured to operator guide.

2.06 DOOR ASSEMBLY

A. Counter Door: Overhead coiling door formed with curtain of interlocking metal slats.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

- a. Cookson Company.
 - b. Cornell Iron Works, Inc.
 - c. Raynor.
- B. Operation Cycles: Not less than 20,000.
- C. Door Curtain Material: Galvanized steel.
- D. Door Curtain Slats: Flat profile slats of 1-1/4-inch or 1-1/2-inch center-to-center height.
- E. Curtain Jamb Guides: Galvanized steel with exposed finish matching curtain slats.
- F. Hood: Match curtain material and finish.
- 1. Shape: As shown on Drawings.
 - 2. Mounting: Face of wall.
- G. Sill Configuration for Counter Door: No sill. See Division 12 Section "Stainless Steel Countertops."
- H. Locking Devices: Equip door with chain lock keeper.
- I. Manual Door Operator: Chain-hoist operator.
- J. Door Finish:
- 1. Stainless-Steel Finish: No. 4 (polished directional satin).

2.07 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.08 STAINLESS-STEEL FINISHES

- A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
- B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.
- 1. Run grain of directional finishes with long dimension of each piece.
 - 2. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

PART 3 - EXECUTION**3.01 EXAMINATION**

- A. Examine substrates areas and conditions, with Installer present, for compliance with requirements for substrate construction and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install overhead coiling doors and operating equipment complete with necessary hardware, anchors, inserts, hangers, and equipment supports; according to manufacturer's written instructions and as specified.
- B. Install overhead coiling doors, hoods, and operators at the mounting locations indicated for each door.
- C. Accessibility: Install overhead coiling doors, switches, and controls along accessible routes in compliance with regulatory requirements for accessibility.

3.03 ADJUSTING

- A. Adjust hardware and moving parts to function smoothly so that doors operate easily, free of warp, twist, or distortion.
- B. Lubricate bearings and sliding parts as recommended by manufacturer.

END OF SECTION 08 33 25

SECTION 08 34 19
INDUSTRIAL FOUR-FOLD DOORS**PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. This Section includes Four-Fold metal doors with surface mounted tube frames
- B. Operation of Four-Fold metal doors includes overhead mounted electro-mechanical operators.

1.03 SUBMITTALS

- A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.
- B. Product Data for each type of product specified consisting of manufacturer's technical Product Data and installation instructions for each type of door required, including data substantiating that products comply with requirements.
- C. Submittal Drawings showing fabrication and installation of Four-Fold metal doors including plans, elevations, sections, details of components, hardware, operating mechanism, and attachments to the other units of Work. Include wiring diagrams for coordination with electrical trade.
- D. Reference list including (5) successful installations of this type of door within the past two (2) years.

1.04 QUALITY ASSURANCE

- A. Door manufacturer shall have at least 10 years experience in manufacturing door type specified for emergency vehicle applications.

PART 2 - PRODUCTS**2.01 PERFORMANCE REQUIREMENTS**

- A. Doors shall be designed to withstand external or internal horizontal wind loads of 20 pounds minimum per square foot.
- B. The maximum allowable deflection shall not exceed 1/120 of the span, acting vertically, across the entire door opening. Flexural stresses in main members shall be limited to 27,000 pounds per square inch. Steel frames shall be designed in accordance with the AISC "Steel Construction Manual".
 - 1. Basis of calculations: See loading geometry shown in Fig. 1 below.

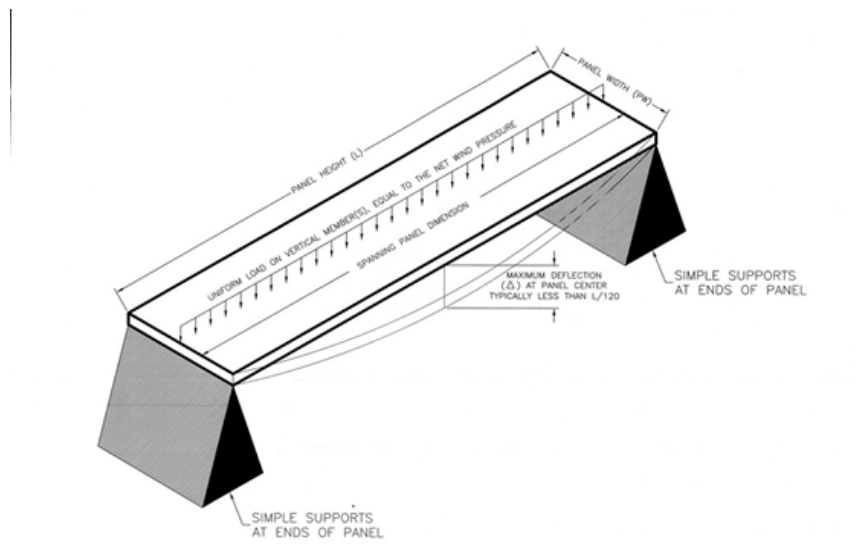


Fig. 1

2.02 MANUFACTURERS

- A. Manufacturers: Four-Fold industrial metal doors manufactured by Electric Power Door or comparable products by other manufacturers meeting all performance requirements and if approved in advance by Architect.

1. Model: Model 39 Hydraulic Four-Fold Doors with Catenary Notch.

2.03 MATERIALS

- A. Structural Steel: ASTM A36/A36M.
- B. Steel Sheets: Steel sheets of commercial quality, complying with ASTM A366/A366M cold-rolled steel sheet, or A569/A569M hot-rolled steel sheet.
- C. Steel Tubing, Electric Welded: ASTM A513.
- D. Steel Tubing, Structural Welded: ASTM A500 Grade B.
- E. Hardware: Manufacturer's standard components.
- F. Fasteners: Zinc-coated steel.

2.04 FOUR-FOLD DOORS

- A. Construction: Provide doors with both horizontal and vertical structural framing. Door framing shall be minimum 14-gauge structural steel tube with 14-gauge steel sheet on the exterior and interior faces.
1. Sheeting shall be formed on the vertical edges with no visible welds on the interior or exterior panel faces.
 2. All frames and framing members shall be true to dimension and square in all directions, and no door shall be bowed, warped, or out of line, in the vertical or horizontal plane of the door opening by more than 1/8 inch in 20 feet.
 3. Exposed welds and welds which interfere with the installation of various parts shall be ground smooth and flush.

4. Door sections shall be insulated with 2 inches of fiberglass batt insulation to provide a u-value of 0.12 or less. Insulation material shall be fitted to cover the entire surface of the door panel between structural members.
 5. Provide cut-out notch in center door panels to accommodate catenary when in closed position. Provide di-electric silicon rubber seal, field cut, to close around catenary and make weather-tight.
- B. Structural Frame: Provide structural frame of welded construction with all joints ground smooth wherever exposed and/or where sheeting overlaps the framing members All hinges, track supports and operator supports shall be factory attached.
- C. Factory finish: All exposed steel shall be shop primed in preparation for field finishing.
- D. Operating Hardware: Provide hardware, including guide tracks and brackets, trolleys, center guides, not less than three pairs of jamb and fold hinges per opening, and all bolts, nuts, fasteners, etc. necessary for complete installation and operation, and as follows:
1. Jamb Hinges: Construct from steel 3 inch x 3/8 inch bar. Any seams where the barrel of the jamb hinge joins the strap must be fully welded. A pair of gussets consisting of 1inch x 3/8 inch x 21inch long steel bars shall be welded to the surface of the hinge strap and barrel. Each hinge shall be supported on Timken roller bearings properly sized to carry the weight of the jamb and center door panels. Jamb hinges shall be attached to the door panel with through bolted connections. Grease zerk fittings shall be provided on all hinge barrels for greasing hinge pintles.
 2. Door Guides: The door guides shall be an upside down channel fabricated from 1/4 inch thick steel plate. Include wall support brackets.. Guides shall be capable of being mounted within 4 inch headroom.
 3. Guide Roller Assemblies: The door shall have a minimum of two anti-friction bearing guide rollers. The guide rollers shall be of sufficient size to transmit the windload from the door panel to the steel door guides.
- E. Weatherstripping: Material shall be adjustable and readily replaceable and provide a substantially weather-tight installation. Weatherstripping at center shall be 1/16 " cloth inserted neoprene. Weatherstripping at sill shall be 1/16 inch cloth inserted neoprene on interior and exterior. Weatherstripping shall be retained continuously.
- F. Perimeter Weatherstripping: Provide jamb and head weatherstripping of 1/16inch cloth-inserted neoprene bulb (or closed cell neoprene).
- G. Vision Panels or grilles: Provide vision panels or grilles of the size, shape and location as noted on the drawings.

2.05 OPERATOR

- A. Each Four-Fold door shall be hydraulically operated using one (1) jamb mounted cylinder per side. There shall be no more than five pivot points in the jamb mounted door actuator mechanism with no sliding or rolling contact points. Hydraulic door operators shall not use a geared "rack & pinion" operating system of any type to provide motion to doors. The use of overhead rotary or jamb mounted rotary actuators will not be allowed. The hydraulic cylinder rods shall extend from the hydraulic cylinder and be in the retracted position when the door is closed.

-
- B. Operator shall be instantly reversible, open and close rapidly and start and stop gradually. Operator shall be adjustable to allow door to fully clear the opening. Operator shall automatically lock the door in the closed position. Operator shall be equipped with disengaging mechanism to convert to free wheeling mode for manual operation.
- C. The operator shall be furnished complete and shall consist of a hydraulic power unit complete with integral pump, hydraulic reservoir, hydraulic control manifold block and attached electric motor. Control panel(s), adjustable limits, hydraulic cylinders, push button station(s), and all necessary brackets, hydraulic hoses and fittings to provide smooth and satisfactory operation shall be provided.
- D. Operator shall open or close the door, starting the door in motion smoothly and then accelerating the door panels to mid-swing and decelerate the panels to an adjustable slow and smooth stop.
- E. Each hydraulic actuator shall be mounted onto the wall adjacent to the jamb panel hinges and require less than 14 inches of wall space. Approximately 2 foot -6 inches of side-room (measured from the edge of the door jamb), or 1 foot -8 inches of side room (measured from the jamb panel hinge centerline) shall be required to swing the jamb panel 105 degrees for full operation.
- F. Actuators shall not extend out from the door more than 18 inches when the door is closed.
- G. Provide an emergency override of the hydraulic system that will enable the doors to be manually operated in case of a power failure.
1. Door panels shall be free to operate manually after the emergency override system has been activated.
- H. The powered opening and closing motion of the left and right hand door panels shall automatically resynchronize themselves without adjustments to any limit switches after the emergency override has been reset and the doors have been returned to powered operation.
- I. Pump Unit: Each pump unit shall be rated by the manufacturer to provide a minimum flow rate of 3 gallons per minute at 1,100 psi hydraulic pressure. Pump units shall consist of the following:
1. Electric Motor: Electric motor driving the pump shall be suitable for operation on 3 phase, 460 volts AC power Specify different voltage if required and of sufficient horsepower and torque to move door in either direction from any position to produce an average door travel speed measured from the leading edge of the jamb panel of not less than two-thirds, nor more than one foot per second, without exceeding the rated capacity of the motor. The motor shall be totally enclosed with fan cooling (TEFC) and conform to NEMA Design "B" (Code J) standards with an insulation class of F4. Motor horsepower rating shall be 2 H.P. minimum, with service factor rating equal to or greater than 1.15
 2. Electric motor shall be of sufficient size to operate doors under normal operating conditions at no more than 75 percent of rated capacity. The motor shall be wound for three phase 208/230/480 (select one) VAC, 60 Hertz operation.
 3. Hydraulic Reservoir Tank: Each reservoir tank shall have a hydraulic oil capacity of 4.5 gallons and be equipped with an oil level sight glass and removable lid. An

- additional combination electronic low level/high temperature hydraulic oil sensing switch shall be factory wired to a NEMA 4 electrical junction box permanently attached to the reservoir unit.
4. A precision hydraulic gear pump with a screened oil strainer shall be connected to the suction side of the pump. The pump shall be mounted inside the reservoir and connected to the motor with a suitable self-aligning coupling.
 5. Hydraulic control valves shall be incorporated into a single machined aluminum manifold block that is attached to the lid of the hydraulic reservoir and shall be removable without removing the lid from the reservoir. The manifold shall be designed to smoothly start the doors into motion and then increase the speed to the maximum at mid-cycle, and then slow the doors to a smooth stop. All movements shall be smooth and controlled. The valves in the manifold shall be capable of independently adjusting the operator's over-all speed, the closing speed, and the deceleration (checking speed) near the end of opening and closing cycles. Needle type flow control valves shall be provided in the manifold to allow for manual operation of the doors without disconnecting cylinder actuators from the door panels. Additional hydraulic components consisting of pressure relief valve, back-flow check valve, manual operation valves, synchronization valve, oil filter, oil filled pressure gauge with snubber and shut-off valve shall be incorporated into the manifold. Solenoid operated directional control and cushioning valves shall be installed into the manifold and factory wired into the NEMA 4 electrical junction box. Each solenoid shall be connected with a field detachable weather resistant DIN connector that includes a red LED indicator. The use of individual hydraulic flow control valves to synchronize the operator speeds, or hydraulic fittings to connect the required valves will not be allowed.
 6. Pump Enclosure: Provide a ventilated, lockable steel enclosure with hinged door to fully surround the pump unit assembly. Enclosure wall, top and floor shall be designed and fabricated to prevent intrusion with normal hand tools. Provide wall-mounting brackets for motor pump assembly and/or pump enclosure assembly.
 7. Door Position Switches: Provide limits to be used exclusively for indicating if the door is in the opened or closed position.
 8. A sufficient quantity of hydraulic hose shall be supplied to interconnect the pump unit to the door operators. The hydraulic hose shall be 3/8 inch minimum inside diameter and consist of an inner synthetic rubber tube with one braid of high-tensile strength steel wire reinforcement and an outer synthetic rubber cover which is resistant to oil, weather and abrasion. The hose shall be capable of operation in temperature ranges between -40 to +250 degrees F. Minimum burst pressure to be 9,000 PSI. Hose to be equivalent to SAE 100 R1 type "AT".
 9. Supply all-temperature hydraulic fluid (-70 to +120 degree F) to fill the pump unit, hydraulic lines and operators. Hydraulic fluid shall be Lubriplate 231052-70.
- J. Electric Controls: Controls shall be furnished by the door manufacturer and shall be complete for each door, and built in accordance with the latest NEMA standards. Control circuits shall not exceed a nominal 110 volts.
1. Controls shall include a programmable logic controller with digital message display. Controller shall include programmable close timers and programmable inputs/outputs
 2. Motor starters shall be magnetic reversing, factory wired with overload and under voltage protection, and equipped with mechanical interlocks. All control components shall be enclosed in one enclosure with a wiring diagram placed on the inside of the cover.

3. Enclosures shall be NEMA 4 with disconnect switch.
4. Pushbuttons (interior) for each door shall have one momentary pressure three-button push-button station marked "OPEN", "CLOSE" and "STOP". Push button enclosure shall be NEMA 4.
5. Limit switches shall be provided to stop the travel of the door in its fully open or fully closed position. Provide auxiliary limit switch to be used for HVAC or exhaust removal system.
6. Safety edges: Provide electric safety edges on leading edge of all doors to reverse door upon contact with obstruction. Provide wireless safety edge transmitters with low battery alarm
7. Photo eyes: Provide (1) exterior, jamb mounted, thru-beam type photo eyes, NEMA 4 rated.
8. Presence Sensor: Provide (2) interior, overhead mounted, presence sensor.
9. Radio controls: Provide one (1) radio receiver and (1) single button remotes per door. Remotes to open and close doors with single button.
10. Wiring: Door manufacturer shall supply controls and components only. Electrical contractor shall install controls and furnish and install conduits and wiring for jobsite power and control wiring.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install Four-Fold metal doors in accordance with the approved drawings by qualified door erection crews. All door openings shall be completely prepared by the general contractor prior to the installation of the doors. Permanent or temporary electric wiring shall be brought to the door opening before installation is started and shall be completed so as not to delay the inspection test.
- B. Doors shall be set plumb, level, and square, and with all parts properly fastened and mounted. All moving parts shall be tested and adjusted and left in good operating condition.

3.02 ADJUSTING AND CLEANING

- A. Inspection of the doors and a complete operating test will be made by the installer in the presence of the general contractor and Architect as soon as the erection is complete. Any defects noted shall be corrected. After door approval in the above test, the general contractor must assume the responsibility for any damage or rough handling of the doors during construction until the building is turned over to the Owner and final inspection is made.
- B. Clean surfaces and repaint abraded or damaged finished surfaces to match factory-applied finish.

END OF SECTION 08 34 19

SECTION 08 36 16**STEEL SECTIONAL DOORS****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section includes electrically operated steel sectional doors.
- B. Related Sections:
 - 1. Division 05 Section "Metal Fabrications" for miscellaneous steel supports.
 - 2. Division 26 Sections for electrical service and connections for powered operators and accessories.

1.03 PERFORMANCE REQUIREMENTS

- A. General Performance: Sectional doors shall meet performance requirements specified without failure due to defective manufacture, fabrication, installation, or other defects in construction and without requiring temporary installation of reinforcing components.
- B. Delegated Design: Design sectional doors, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- C. Structural Performance: Exterior sectional doors shall withstand the effects of gravity loads, and the following loads and stresses within limits and under conditions indicated according to ASCE/SEI 7
 - 1. Wind Loads: As indicated on Drawings.
 - 2. Deflection Limits: Design sectional doors to withstand design wind loads without evidencing permanent deformation or disengagement of door components. Deflection of door in horizontal position (open) shall not exceed 1/120 of the door width.
- D. Air Infiltration: Maximum rate not more than indicated when tested according to ASTM E 283.
 - 1. Air Infiltration: Maximum rate of 0.08 cfm/sq. ft. at 15 and 25 mph.
- E. Windborne-Debris-Impact-Resistance Performance: Provide sectional doors that pass large-missile-impact and cyclic-pressure tests when tested according to ASTM E 1886 and ASTM E 1996.
- F. Seismic Performance: Sectional doors shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

2. Seismic Component Importance Factor: 1.5.

- G. Operation Cycles: Provide sectional door components and operators capable of operating for not less than number of cycles indicated for each door. One operation cycle is complete when a door is opened from the closed position to the fully open position and returned to the closed position.

1.04 SUBMITTALS

- A. Product Data: For each type and size of sectional door and accessory. Include the following:
1. Construction details, material descriptions, dimensions of individual components, profile door sections, and finishes.
 2. Rated capacities, operating characteristics, electrical characteristics, and furnished accessories.
- B. Shop Drawings: For each installation and for special components not dimensioned or detailed in manufacturer's product data. Include plans, elevations, sections, details, and attachments to other work.
1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 2. Wiring Diagrams: For power, signal, and control wiring.
- C. Samples for Initial Selection: Manufacturer's finish charts showing full range of colors and textures available for units with factory-applied finishes.
1. Include similar Samples of accessories involving color selection.
- D. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below:
1. Flat Door Sections: 6 inches square.
 2. Frame for Paneled Door Sections: 6 inches long of each width of stile and rail required.
 3. Panel for Raised-Panel Door Sections: 12 inches square at panel corner, but not smaller than required to show raised-panel profile.
- E. Delegated-Design Submittal: For sectional doors indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
1. Detail fabrication and assembly of seismic restraints.
 2. Summary of forces and loads on walls and jambs.
- F. Qualification Data: For qualified Installer.
- G. Seismic Qualification Certificates: For sectional doors, accessories, and components, from manufacturer.
- H. Maintenance Data: For sectional doors to include in maintenance manuals.
- I. Warranties: Sample of special warranties.

1.05 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for both installation and maintenance of units required for this Project.
- B. Source Limitations: Obtain sectional doors from single source from single manufacturer.
 - 1. Obtain operators and controls from sectional door manufacturer.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Standard for Sectional Doors: Fabricate sectional doors to comply with DASMA 102 unless otherwise indicated.
- E. Regulatory Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA) and Architectural Barriers Act (ABA) Accessibility Guidelines for Buildings and Facilities" and ICC/ANSI A117.1.

1.06 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of sectional doors that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures including, but not limited to, excessive deflection.
 - b. Faulty operation of hardware.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use; rust through.
 - d. Delamination of exterior or interior facing materials.
 - 2. Warranty Period: Two years from date of Substantial Completion.
- B. Special Finish Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components that show evidence of deterioration of factory-applied finishes within specified warranty period.
 - 1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 STEEL DOOR SECTIONS

- A. Exterior Section Faces and Frames: Fabricate from zinc-coated (galvanized), cold-rolled, commercial steel (CS) sheet, complying with ASTM A 653/A 653M, with indicated zinc coating and thickness.
 - 1. Fabricate section faces from single sheets to provide sections not more than 24 inches high and of indicated thickness. Roll horizontal meeting edges to a continuous, interlocking, keyed, rabbeted, shiplap, or tongue-in-groove weathertight seal, with a reinforcing flange return.
 - 2. For insulated doors, provide sections with continuous thermal-break construction, separating the exterior and interior faces of door.

- B. Section Ends and Intermediate Stiles: Enclose open ends of sections with channel end stiles formed from galvanized-steel sheet not less than 0.064-inch- nominal coated thickness and welded to door section. Provide intermediate stiles formed from not less than 0.064-inch- thick galvanized-steel sheet, cut to door section profile, and welded in place. Space stiles not more than 48 inches apart.
- C. Reinforce bottom section with a continuous channel or angle conforming to bottom-section profile and allowing installation of astragal.
- D. Provide reinforcement for hardware attachment.
- E. Board Thermal Insulation: Insulate interior of steel sections with door manufacturer's standard CFC-free polystyrene or polyurethane board insulation, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, according to ASTM E 84; or with glass-fiber-board insulation. Secure insulation to exterior face sheet. Enclose insulation completely within steel sections that incorporate the following interior facing material, with no exposed insulation:
 - 1. Interior Facing Material: Zinc-coated (galvanized), cold-rolled, commercial steel (CS) sheet, complying with ASTM A 653/A 653M, with indicated thickness.
 - 2. Interior Facing Material: Manufacturer's standard prefinished hardboard panel, 1/8 inch thick and complying with ANSI A135.5.
- F. Fabricate sections so finished door assembly is rigid and aligned, with tight hairline joints and free of warp, twist, and deformation.

2.02 TRACKS, SUPPORTS, AND ACCESSORIES

- A. Tracks: Manufacturer's standard, galvanized-steel track system of configuration indicated, sized for door size and weight, designed for lift type indicated and clearances shown on Drawings, and complying with ASTM A 653/A 653M for minimum G60 zinc coating. Provide complete track assembly including brackets, bracing, and reinforcement for rigid support of ball-bearing roller guides for required door type and size. Slot vertical sections of track spaced 2 inches apart for door-drop safety device. Slope tracks at proper angle from vertical or design tracks to ensure tight closure at jambs when door unit is closed.
- B. Track Reinforcement and Supports: Galvanized-steel track reinforcement and support members, complying with ASTM A 36/A 36M and ASTM A 123/A 123M. Secure, reinforce, and support tracks as required for door size and weight to provide strength and rigidity without sag, sway, and vibration during opening and closing of doors.
 - 1. Vertical Track Assembly: Track with continuous reinforcing angle attached to track and attached to wall with jamb brackets.
 - 2. Horizontal Track Assembly: Track with continuous reinforcing angle attached to track and supported at points from curve in track to end of track by laterally braced attachments to overhead structural members.
- C. Weatherseals: Replaceable, adjustable, continuous, compressible weather-stripping gaskets of flexible vinyl, rubber, or neoprene fitted to bottom and top of sectional door unless otherwise indicated.

2.03 HARDWARE

- A. General: Provide heavy-duty, corrosion-resistant hardware, with hot-dip galvanized, stainless-steel, or other corrosion-resistant fasteners, to suit door type.

- B. Hinges: Heavy-duty, galvanized-steel hinges of not less than 0.079-inch- nominal coated thickness at each end stile and at each intermediate stile, according to manufacturer's written recommendations for door size. Attach hinges to door sections through stiles and rails with bolts and lock nuts or lock washers and nuts. Use rivets or self-tapping fasteners where access to nuts is not possible. Provide double-end hinges where required, for doors over 16 feet wide unless otherwise recommended by door manufacturer.
- C. Rollers: Heavy-duty rollers with steel ball-bearings in case-hardened steel races, mounted with varying projections to suit slope of track. Extend roller shaft through both hinges where double hinges are required. Provide 3-inch- diameter roller tires for 3-inch- wide track and 2-inch- diameter roller tires for 2-inch- wide track.
- D. Push/Pull Handles: For push-up or emergency-operated doors, provide galvanized-steel lifting handles on each side of door.

2.04 LOCKING DEVICES

- A. Slide Bolt: Fabricate with side-locking bolts to engage through slots in tracks for locking by padlock, located on single-jamb side, operable from inside only.
- B. Locking Device Assembly: Fabricate with cylinder lock, spring-loaded deadbolt, operating handle, cam plate, and adjustable locking bars to engage through slots in tracks.
 - 1. Lock Cylinders: Provide cylinders specified in Division 08 Section "Door Hardware" and keyed to building keying system.
 - 2. Keys: Three for each cylinder.
- C. Chain Lock Keeper: Suitable for padlock.
- D. Safety Interlock Switch: Equip power-operated doors with safety interlock switch to disengage power supply when door is locked.

2.05 COUNTERBALANCE MECHANISM

- A. Torsion Spring: Counterbalance mechanism consisting of adjustable-tension torsion springs fabricated from steel-spring wire complying with ASTM A 229/A 229M, mounted on torsion shaft made of steel tube or solid steel. Provide springs designed for number of operation cycles indicated.
- B. Weight Counterbalance: Counterbalance mechanism consisting of filled pipe weights that move vertically in a galvanized-steel weight pipe. Connect pipe weights with cable to weight-cable drums mounted on torsion shaft made of steel tube or solid steel.
- C. Cable Drums and Shaft for Doors: Cast-aluminum or gray-iron casting cable drums mounted on torsion shaft and grooved to receive door-lifting cables as door is raised. Mount counterbalance mechanism with manufacturer's standard ball-bearing brackets at each end of torsion shaft. Provide one additional midpoint bracket for shafts up to 16 feet long and two additional brackets at one-third points to support shafts more than 16 feet long unless closer spacing is recommended by door manufacturer.
- D. Cables: Galvanized-steel lifting cables with cable safety factor of at least 7 to 1.
- E. Cable Safety Device: Include a spring-loaded steel or spring-loaded bronze cam mounted to bottom door roller assembly on each side and designed to automatically stop door if either lifting cable breaks.

- F. Bracket: Provide anchor support bracket as required to connect stationary end of spring to the wall and to level the shaft and prevent sag.
- G. Provide a spring bumper at each horizontal track to cushion door at end of opening operation.

2.06 ELECTRIC DOOR OPERATORS

- A. General: Electric door operator assembly of size and capacity recommended and provided by door manufacturer for door and "operation cycles" requirement specified, with electric motor and factory-prewired motor controls, starter, gear-reduction unit, solenoid-operated brake, clutch, remote-control stations, control devices, integral gearing for locking door, and accessories required for proper operation.
 - 1. Comply with NFPA 70.
 - 2. Provide control equipment complying with NEMA ICS 1, NEMA ICS 2, and NEMA ICS 6; with NFPA 70, Class 2 control circuit, maximum 24-V ac or dc.
- B. Usage Classification: Electric operator and components capable of operating for not less than number of cycles per hour indicated for each door.
- C. Door-Operator Type: Unit consisting of electric motor, gears, pulleys, belts, sprockets, chains, and controls needed to operate door and meet required usage classification.
 - 1. Jackshaft, Side Mounted: Jackshaft operator mounted on the inside front wall on right or left side of door and connected to torsion shaft with an adjustable coupling or drive chain.
- D. Electric Motors: Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Division 11 Section "Common Motor Requirements for Equipment" unless otherwise indicated.
 - 1. Electrical Characteristics:
 - a. Phase: Polyphase.
 - b. Volts: 460 V.
 - c. Hertz: 60.
 - 2. Motor Type and Controller: Reversible motor and controller (disconnect switch) for motor exposure indicated.
 - 3. Motor Size: Minimum size as indicated. If not indicated, large enough to start, accelerate, and operate door in either direction from any position, at a speed not less than 8 in./sec. and not more than 12 in./sec., without exceeding nameplate ratings or service factor.
 - 4. Operating Controls, Controllers (Disconnect Switches), Wiring Devices, and Wiring: Manufacturer's standard unless otherwise indicated.
 - 5. Coordinate wiring requirements and electrical characteristics of motors and other electrical devices with building electrical system and each location where installed.
 - 6. Use adjustable motor-mounting bases for belt-driven operators.
- E. Limit Switches: Equip each motorized door with adjustable switches interlocked with motor controls and set to automatically stop door at fully opened and fully closed positions.
- F. Obstruction Detection Device: Equip motorized door with indicated external

automatic safety sensor capable of protecting full width of door opening. Activation of device immediately stops and reverses downward door travel.

1. Photoelectric Sensor: Manufacturer's standard system designed to detect an obstruction in door opening without contact between door and obstruction.
 - a. Self-Monitoring Type: Designed to interface with door operator control circuit to detect damage to or disconnection of sensor device. When self-monitoring feature is activated, door closes only with sustained pressure on close button.
- G. Remote-Control Station: Momentary-contact, three-button control station with push-button controls labeled "Open," "Close," and "Stop."
 1. Interior units, full-guarded, surface-mounted, heavy-duty type, with general-purpose NEMA ICS 6, Type 1 enclosure.
 2. Exterior units, full-guarded, standard-duty, surface-mounted, weatherproof type, NEMA ICS 6, Type 4 enclosure, key operated.
- H. Emergency Manual Operation: Equip each electrically powered door with capability for emergency manual operation. Design manual mechanism so required force for door operation does not exceed 25 lbf.
- I. Emergency Operation Disconnect Device: Equip operator with hand-operated disconnect mechanism for automatically engaging manual operator and releasing brake for emergency manual operation while disconnecting motor without affecting timing of limit switch. Mount mechanism so it is accessible from floor level. Include interlock device to automatically prevent motor from operating when emergency operator is engaged.
- J. Motor Removal: Design operator so motor may be removed without disturbing limit-switch adjustment and without affecting emergency manual operation.
- K. Audible and Visual Signals: Audible alarm and visual indicator lights in compliance with regulatory requirements for accessibility.
- L. Radio-Control System: Consisting of the following:
 1. Three-channel universal coaxial receiver to open, close, and stop door; two per operator.
 2. Multifunction remote control.
 3. Remote antenna and mounting kit.

2.07 PNEUMATIC DOOR OPERATORS, WET DOORS

- A. General: Provide operators of size recommended by manufacturer for door size, weight, and movement; for condition of exposure; and for long-term, maintenance-free operation under traffic load for type of occupancy indicated.
 1. Operators shall start, accelerate, and operate door in either direction from any position, at not less than 2/3 fps and not more than 1 fps.
- B. Pneumatic Operating System: Pneumatic operator, air opened and counterbalance closed, checking in both cycles, with doors manually operable when power is off.
 1. Compressed Air Power Unit: As specified in Division 11 Section "Vehicle Service Equipment."

- C. Disconnect Device: Failsafe operation that allows drawbar carriage to slide along drawbar cylinder in event of electrical or compressed air failure.
- D. Design operator so overhead door may be operated without disturbing limit-switch adjustment.
- E. Door-Operator Type: Trolley or drawbar carriage type unit consisting of pneumatically operated direct magnetic drive and the following:
 - 1. Quick release for manual operation.
 - 2. Minimum 2 inch diameter Type 304 or 316 stainless steel drawbar cylinder.
 - 3. Piston magnetically coupled to a carriage connected to a drawbar cylinder
 - 4. Carriage with integral wiper seal built-in to prevent dust accumulation on cylinder.
 - 5. Sealed stainless steel shock absorbing piston cylinder operating within the following compressed air requirements:
 - a. Air Volume: Not less than 0.2 CFM; not more than 0.4 CFM.
 - b. Air Pressure: Not less than 50 PSIp; not more than 90 PSI.
 - 6. 1/4" NPT x 3/8" non-corrosive airline fittings on piston cylinder.
 - 7. Type 304 or 316 stainless steel brackets and fasteners.
- F. Remote-Control Station: Provide the following:
 - 1. Provide full-guarded, standard-duty, surface-mounted, weatherproof-type exterior unit with NEMA ICS 6, Type 4 enclosure.
 - 2. Provide momentary-contact, two-button control station with illuminated push-button controls labeled "Open" and "Close." Include emergency open button that opens overhead door in case of power failure. Buttons shall comply with requirements for NEMA ICS 6, Type 4 enclosure.
 - 3. Provide automatic compressed air valves mounted with gaskets. O-rings will not be accepted.
 - 4. Provide compressed air noise relief mufflers.
 - 5. Microprocessor Control Unit: Solid-state controls with 24 VAC fused circuitry.
 - 6. Terminal Connections: Provide not less than 10 places for electrical connections.
 - 7. Provide pre-wired electric eye pin sockets.
 - 8. Mounting: Surface.
- G. Operator Features:
 - 1. Adjustable opening and closing speed.
 - 2. Adjustable backcheck.
 - 3. Adjustable hold-open time of not less than 0 to 30 seconds.
 - 4. Adjustable time delay.
 - 5. Adjustable limit switch.
 - 6. Obstruction recycle.
- H. Automatic Oiler: Provide in-line oiler that automatically drops controlled amounts of oil into compressed air lines.
- I. Inline Airline Dryer: Provide in-line dryer that removes excess water from compressed air and prevents build-up of water in air lines.
- J. Obstruction Detection Device: Provide each motorized door with indicated external automatic safety sensor capable of protecting full width of door opening. Activation of sensor immediately stops and reverses downward door travel.

1. Photoelectric Sensor: Manufacturer's standard system designed to detect an obstruction in door opening without contact between door and obstruction.
 2. Pressure-Sensor Edge: Provide each pneumatically operated door with an automatic safety sensor edge, located within astragal or weather stripping mounted to bottom bar. Contact with sensor immediately stops and reverses downward door travel. Connect to control circuit using manufacturer's standard take-up reel or self-coiling cable.
 - a. Provide pneumatically actuated automatic bottom bar.
- K. Limit Switches: Adjustable switches interlocked with motor controls and set to automatically stop door at fully opened and fully closed positions.

2.08 DOOR ASSEMBLY

- A. Steel Sectional Door: Sectional door formed with hinged sections.
1. Basis of Design: Subject to performance requirements, provide Thermospan 200 Doors by Wayne-Dalton or a comparable product by one of the following:
 - a. C.H.I. Overhead Doors.
 - b. Clopay Building Products; a Griffon company.
 - c. Raynor.
 2. Products by Overhead Door Corporation will not be accepted.
 3. Products by Airlift Doors Inc. will not be accepted.
- B. Operation Cycles: Not less than 50,000
- C. Installed R-Value: 17.5
- D. Steel Sections: Zinc-coated (galvanized) steel sheet with G60 zinc coating.
1. Section Thickness: 2 inches nominal.
 2. Exterior-Face, Steel Sheet Thickness: 0.022-inch nominal coated thickness.
 - a. Surface: Manufacturer's standard, grooved.
 3. Insulation: Foamed-in-place polyurethane.
 4. Interior Facing Material: Zinc-coated (galvanized) steel sheet of manufacturer's recommended thickness to meet performance requirements nominal coated thickness.
- E. Track Configuration: Standard-lift track, minimum 3 inches wide.
- F. Weatherseals: Fitted to bottom and top and around entire perimeter of door
- G. Roller-Tire Material: Case-hardened steel, 3-inch diameter to fit 3-inch wide track..
- H. Locking Devices: Equip door with chain lock keeper.
- I. Counterbalance Type: Torsion spring.

2.09 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

- B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.10 STEEL AND GALVANIZED-STEEL FINISHES

- A. Factory Prime Finish: Manufacturer's standard primer, compatible with field-applied finish. Comply with coating manufacturer's written instructions for cleaning, pretreatment, application, and minimum dry film thickness.
- B. Powder-Coat Finish: Manufacturer's standard baked-on finish consisting of prime coat and thermosetting topcoat. Comply with coating manufacturer's written instructions for cleaning, pretreatment, application, and minimum dry film thickness. Match exterior metal panels.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for substrate construction and other conditions affecting performance of the Work.
- B. Examine locations of electrical connections.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install sectional doors and operating equipment complete with necessary hardware, anchors, inserts, hangers, and equipment supports; according to manufacturer's written instructions and as specified.
- B. Tracks:
 - 1. Fasten vertical track assembly to opening jambs and framing, spaced not more than 24 inches apart.
 - 2. Hang horizontal track assembly from structural overhead framing with angles or channel hangers attached to framing by welding or bolting, or both. Provide sway bracing, diagonal bracing, and reinforcement as required for rigid installation of track and door-operating equipment.
 - 3. Repair galvanized coating on tracks according to ASTM A 780.
- C. Accessibility: Install sectional doors, switches, and controls along accessible routes in compliance with regulatory requirements for accessibility.

3.03 STARTUP SERVICES

- A. Engage a factory-authorized service representative to perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.04 ADJUSTING

- A. Adjust hardware and moving parts to function smoothly so that doors operate easily, free of warp, twist, or distortion.
- B. Lubricate bearings and sliding parts as recommended by manufacturer.
- C. Adjust doors and seals to provide weathertight fit around entire perimeter.
- D. Align and adjust motors, pulleys, belts, sprockets, chains, and controls according to manufacturer's written instructions.
- E. Touch-up Painting: Immediately after welding galvanized materials, clean welds and abraded galvanized surfaces and repair galvanizing to comply with ASTM A 780.

3.05 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain sectional doors.

END OF SECTION 08 36 16

SECTION 08 41 13**ALUMINUM-FRAMED STOREFRONTS AND WINDOWS**

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section Includes:
 - 1. Exterior and interior storefront framing.
 - 2. Exterior and interior manual-swing entrance doors and door-frame units.
 - 3. Exterior fixed windows in storefront framing.

1.03 DEFINITIONS

- A. ADA/ABA Accessibility Guidelines: U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disability Act (ADA) and Architectural Barriers Act (ABA) Accessibility Guidelines for Buildings and Facilities."

1.04 PERFORMANCE REQUIREMENTS

- A. General Performance: Aluminum-framed systems shall withstand the effects of the following performance requirements without exceeding performance criteria or failure due to defective manufacture, fabrication, installation, or other defects in construction:
 - 1. Movements of supporting structure indicated on Drawings including, but not limited to, story drift and deflection from uniformly distributed and concentrated live loads.
 - 2. Dimensional tolerances of building frame and other adjacent construction.
 - 3. Failure includes the following:
 - a. Deflection exceeding specified limits.
 - b. Thermal stresses transferring to building structure.
 - c. Framing members transferring stresses, including those caused by thermal and structural movements to glazing.
 - d. Glazing-to-glazing contact.
 - e. Noise or vibration created by wind and by thermal and structural movements.
 - f. Loosening or weakening of fasteners, attachments, and other components.
 - g. Sealant failure.
 - h. Failure of operating units.
- B. Delegated Design: Design aluminum-framed systems, including comprehensive engineering analysis by a qualified professional engineer licensed to practice in the state where the project is located, using performance requirements and design criteria indicated.
- C. Structural Loads:
 - 1. Wind Loads: As indicated on Drawings.
 - 2. Seismic Loads: As indicated on Drawings.

- D. Deflection of Framing Members:
1. Deflection Normal to Wall Plane: Limited to edge of glass in a direction perpendicular to glass plane shall not exceed $L/175$ of the glass edge length for each individual glazing lite or an amount that restricts edge deflection of individual glazing lites to $3/4$ inch, whichever is less.
 2. Deflection Parallel to Glazing Plane: Limited to $L/360$ of clear span or $1/8$ inch, whichever is smaller.
- E. Structural-Test Performance: Provide aluminum-framed systems tested according to ASTM E 330 as follows:
1. When tested at positive and negative wind-load design pressures, systems do not evidence deflection exceeding specified limits.
 2. When tested at 150 percent of positive and negative wind-load design pressures, systems, including anchorage, do not evidence material failures, structural distress, and permanent deformation of main framing members exceeding 0.2 percent of span.
 3. Test Durations: As required by design wind velocity, but not fewer than 10 seconds.
- F. Air Infiltration: Provide aluminum-framed systems with maximum air leakage through fixed glazing and framing areas of 0.06 cfm/sq. ft. of fixed wall area when tested according to ASTM E 283 at a minimum static-air-pressure difference of 1.57 lbf/sq. ft.
- G. Water Penetration under Static Pressure: Provide aluminum-framed systems that do not evidence water penetration through fixed glazing and framing areas when tested according to ASTM E 331 at a minimum static-air-pressure difference of 20 percent of positive wind-load design pressure, but not less than 6.24 lbf/sq. ft.
1. Maximum Water Leakage: According to AAMA 501.1. Water leakage does not include water controlled by flashing and gutters that is drained to exterior and water that cannot damage adjacent materials or finishes.
- H. Thermal Movements: Provide aluminum-framed systems that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.
 2. Test Performance: No buckling; stress on glass; sealant failure; excess stress on framing, anchors, and fasteners; or reduction of performance when tested according to AAMA 501.5.
 - a. High Exterior Ambient-Air Temperature: That which produces an exterior metal-surface temperature of 180 deg F.
 - b. Low Exterior Ambient-Air Temperature: 0 deg F.
 3. Interior Ambient-Air Temperature: 75 deg F.
- I. Condensation Resistance: Provide aluminum-framed systems with fixed glazing and framing areas having condensation-resistance factor (CRF) of not less than 45 when tested according to AAMA 1503.
- J. Thermal Conductance: Provide aluminum-framed systems with fixed glazing and framing areas having an average U-factor of not more than 0.57 Btu/sq. ft. x h x deg F when tested according to AAMA 1503.

- K. Structural Sealant: Capable of withstanding tensile and shear stresses imposed by aluminum-framed systems without failing adhesively or cohesively. When tested for preconstruction adhesion and compatibility, cohesive failure of sealant shall occur before adhesive failure.
1. Adhesive failure occurs when sealant pulls away from substrate cleanly, leaving no sealant material behind.
 2. Cohesive failure occurs when sealant breaks or tears within itself but does not separate from each substrate because sealant-to-substrate bond strength exceeds sealant's internal strength.
- L. Structural-Sealant Joints: Designed to produce tensile or shear stress of less than 20 psi.

1.05 SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for aluminum-framed systems.
- B. Shop Drawings: For aluminum-framed systems. Include plans, elevations, sections, details, and attachments to other work.
1. Include details of provisions for system expansion and contraction and for drainage of moisture in the system to the exterior.
 2. For entrance doors, include hardware schedule and indicate operating hardware types, functions, quantities, and locations.
- C. Samples for Initial Selection: For units with factory-applied color finishes.
- D. Samples for Verification: For each type of exposed finish required, in manufacturer's standard sizes.
- E. Fabrication Sample: Of each vertical-to-horizontal intersection of aluminum-framed systems, made from 12-inch lengths of full-size components and showing details of the following:
1. Joinery, including concealed welds.
 2. Anchorage.
 3. Expansion provisions.
 4. Glazing.
 5. Flashing and drainage.
- F. Other Action Submittals:
1. Entrance Door Hardware Schedule: Prepared by or under the supervision of supplier, detailing fabrication and assembly of entrance door hardware, as well as procedures and diagrams. Coordinate final entrance door hardware schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of entrance door hardware.
- G. Delegated-Design Submittal: For aluminum-framed systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
1. Detail fabrication and assembly of aluminum-framed systems.
 2. Include design calculations.

- H. Qualification Data: For qualified Installer.
- I. Seismic Qualification Certificates: For aluminum-framed systems, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
- J. Welding certificates.
- K. Preconstruction Test Reports: For sealant.
- L. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for aluminum-framed systems, indicating compliance with performance requirements.
- M. Source quality-control reports.
- N. Quality-Control Program for Structural-Sealant-Glazed System: Include reports.
- O. Field quality-control reports.
- P. Maintenance Data: For aluminum-framed systems to include in maintenance manuals.
- Q. Warranties: Sample of special warranties.

1.06 QUALITY ASSURANCE

- A. Source Limitations for Aluminum-Framed Systems: Obtain Aluminum Framed Entrances and Storefront and Curtain Wall System from single source from single manufacturer.
- B. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
- C. Testing Agency Qualifications: Qualified according to ASTM E 699 for testing indicated.
- D. Engineering Responsibility: Prepare data for aluminum-framed systems, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in systems similar to those indicated for this Project.
- E. Quality-Control Program for Structural-Sealant-Glazed System: Develop quality control program specifically for Project. Document quality-control procedures and verify results for aluminum-framed systems. Comply with ASTM C 1401 recommendations including, but not limited to, system material-qualification procedures, preconstruction sealant-testing program, procedures for system fabrication and installation, and intervals of reviews and checks.
- F. Product Options: Information on Drawings and in Specifications establishes requirements for systems' aesthetic effects and performance characteristics. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction. Performance characteristics are indicated by criteria subject to verification by one or more methods including preconstruction testing, field testing, and in-service performance.

1. Do not revise intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If revisions are proposed, submit comprehensive explanatory data to Architect for review.
- G. Accessible Entrances: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines and ICC/ANSI A117.1.
- H. Welding Qualifications: Qualify procedures and personnel according to AWS D1.2, "Structural Welding Code - Aluminum."
- I. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.
1. Build mockup of typical wall area as shown on Drawings.
 2. Field testing shall be performed on mockups according to requirements in "Field Quality Control" Article.
 3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 4. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
- J. Preinstallation Conference: Conduct conference at Project site.

1.07 PROJECT CONDITIONS

- A. Field Measurements: Verify actual locations of structural supports for aluminum-framed systems by field measurements before fabrication and indicate measurements on Shop Drawings.

1.08 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of aluminum-framed systems that do not comply with requirements or that fail in materials or workmanship within specified warranty period.
1. Failures include, but are not limited to, the following:
 - a. Structural failures including, but not limited to, excessive deflection.
 - b. Noise or vibration caused by thermal movements.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
 - d. Adhesive or cohesive sealant failures.
 - e. Water leakage through fixed glazing and framing areas.
 - f. Failure of operating components.
 2. Warranty Period: Two years from date of Substantial Completion.
- B. Special Finish Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components on which finishes do not comply with requirements or that fail in materials or workmanship within specified warranty period. Warranty does not include normal weathering.
1. Warranty Period: Five years from date of Substantial Completion.

1.09 MAINTENANCE SERVICE

A. Entrance Door Hardware:

1. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of entrance door hardware.
2. Initial Maintenance Service: Beginning at Substantial Completion, provide six months' full maintenance by skilled employees of entrance door hardware Installer. Include quarterly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper entrance door hardware operation at rated speed and capacity. Provide parts and supplies the same as those used in the manufacture and installation of original equipment.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Trifab 451T Storefront Framing System by Kawneer North America or comparable product by one of the following:
1. Arcadia, Inc.
 2. EFCO Corporation.
 3. Tubelite.
 4. United States Aluminum.
 5. Vistawall Architectural Products; The Vistawall Group; a Bluescope Steel company.
 6. Wausau Window and Wall Systems.

2.02 MATERIALS

- A. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
1. Sheet and Plate: [ASTM B 209](#).
 2. Extruded Bars, Rods, Profiles, and Tubes: [ASTM B 221](#).
 3. Extruded Structural Pipe and Tubes: [ASTM B 429](#).
 4. Structural Profiles: [ASTM B 308/B 308M](#).
 5. Welding Rods and Bare Electrodes: [AWS A5.10/A5.10M](#).
- B. Steel Reinforcement: Manufacturer's standard zinc-rich, corrosion-resistant primer, complying with SSPC-PS Guide No.12.00; applied immediately after surface preparation and pretreatment. Select surface preparation methods according to recommendations in SSPC-SP COM and prepare surfaces according to applicable SSPC standard.
1. Structural Shapes, Plates, and Bars: [ASTM A 36/A 36M](#).
 2. Cold-Rolled Sheet and Strip: [ASTM A 1008/A 1008M](#).
 3. Hot-Rolled Sheet and Strip: [ASTM A 1011/A 1011M](#).

2.03 FRAMING SYSTEMS

- A. Framing Members: Manufacturer's standard extruded-aluminum framing members of thickness required and reinforced as required to support imposed loads.
1. Construction: Thermally broken.

2. Glazing System: Retained mechanically with gaskets on four sides.
 3. Glazing Plane: Center.
- B. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.
- C. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.
1. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
 2. Reinforce members as required to receive fastener threads.
- D. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts, complying with ASTM A 123/A 123M or ASTM A 153/A 153M.
- E. Concealed Flashing: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding flashing compatible with adjacent materials.
- F. Framing System Gaskets and Sealants: Manufacturer's standard, recommended by manufacturer for joint type.
1. Provide sealants for use inside of the weatherproofing system that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.04 ENTRANCE DOOR SYSTEMS

- A. Entrance Doors: Manufacturer's standard glazed entrance doors for manual-swing operation.
1. Door Construction: 1-3/4-inch overall thickness, with minimum 0.125-inch overall thickness, with minimum 0.188-inch-thick, extruded-aluminum tubular rail and stile members. Mechanically fasten corners with reinforcing brackets that are deeply penetrated and fillet welded or that incorporate concealed tie rods.
 - a. Thermal Construction: High-performance plastic connectors separate aluminum members exposed to the exterior from members exposed to the interior.
 2. Door Design: As indicated.
 - a. Accessible Doors: Smooth surfaced for width of door in area within 10 inches above floor or ground plane.
 3. Glazing Stops and Gaskets: Beveled, snap-on, extruded-aluminum stops and preformed gaskets.
 - a. Provide nonremovable glazing stops on outside of door.
- B. Entrance Door Hardware: As specified in Division 08 Section "Door Hardware."

2.05 GLAZING SYSTEMS

- A. Glazing: As specified in Division 08 Section "Glazing."

2.06 ACCESSORY MATERIALS

- A. Joint Sealants: For installation at perimeter of aluminum-framed systems, as specified in Division 07 Section "Joint Sealants."
 - 1. Provide sealants for use inside of the weatherproofing system that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Bituminous Paint: Cold-applied, asphalt-mastic paint complying with SSPC-Paint 12 requirements except containing no asbestos; formulated for 30-mil thickness per coat.

2.07 FABRICATION

- A. Form or extrude aluminum shapes before finishing.
- B. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.
- C. Framing Members, General: Fabricate components that, when assembled, have the following characteristics:
 - 1. Profiles that are sharp, straight, and free of defects or deformations.
 - 2. Accurately fitted joints with ends coped or mitered.
 - 3. Means to drain water passing joints, condensation within framing members, and moisture migrating within the system to exterior.
 - 4. Physical and thermal isolation of glazing from framing members.
 - 5. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
 - 6. Provisions for field replacement of glazing from exterior.
 - 7. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.
- D. Mechanically Glazed Framing Members: Fabricate for flush glazing without projecting stops.
- E. Structural-Sealant-Glazed Framing Members: Include accommodations for using temporary support device to retain glazing in place while structural sealant cures.
- F. Storefront Framing: Fabricate components for assembly using head-and-sill-receptor system with shear blocks at intermediate horizontal members.
- G. Entrance Door Frames: Reinforce as required to support loads imposed by door operation and for installing entrance door hardware.
 - 1. At exterior doors, provide compression weather stripping at fixed stops.
 - 2. At interior doors, provide silencers at stops to prevent metal-to-metal contact. Install three silencers on strike jamb of single-door frames and two silencers on head of frames for pairs of doors.
- H. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

2.08 ALUMINUM FINISHES

- A. High-Performance Organic Finish: Three-coat fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal

surfaces to comply with coating and resin manufacturers' written instructions.

1. Color and Gloss: Match Concealed-Fastener Lap Seam Metal Wall Panels.

2.09 SOURCE QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to evaluate structural-sealant-glazed systems.
- B. Structural-Sealant-Glazed Systems: Perform quality-control procedures complying with ASTM C 1401 recommendations, including, but not limited to, system material-qualification procedures, sealant testing, and system fabrication reviews and checks.
- C. Structural-sealant-glazed system will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. General:
 1. Comply with manufacturer's written instructions.
 2. Do not install damaged components.
 3. Fit joints to produce hairline joints free of burrs and distortion.
 4. Rigidly secure nonmovement joints.
 5. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration.
 6. Seal joints watertight unless otherwise indicated.
- B. Metal Protection:
 1. Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or applying sealant or tape, or by installing nonconductive spacers as recommended by manufacturer for this purpose.
 2. Where aluminum will contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.
- C. Install components to drain water passing joints, condensation occurring within framing members, and moisture migrating within the system to exterior.
- D. Set continuous sill members and flashing in full sealant bed as specified in Division 07 Section "Joint Sealants" to produce weathertight installation.
- E. Install components plumb and true in alignment with established lines and grades, and without warp or rack.

- F. Install glazing as specified in Division 08 Section "Glazing."
1. Structural-Sealant Glazing:
 - a. Prepare surfaces that will contact structural sealant according to sealant manufacturer's written instructions to ensure compatibility and adhesion. Preparation includes, but is not limited to, cleaning and priming surfaces.
 - b. Install weatherseal sealant according to Division 07 Section "Joint Sealants" and according to sealant manufacturer's written instructions to produce weatherproof joints. Install joint filler behind sealant as recommended by sealant manufacturer.
 - G. Entrance Doors: Install doors to produce smooth operation and tight fit at contact points.
 1. Exterior Doors: Install to produce weathertight enclosure and tight fit at weather stripping.
 2. Field-Installed Entrance Door Hardware: Install surface-mounted entrance door hardware according to entrance door hardware manufacturers' written instructions using concealed fasteners to greatest extent possible.
 - H. Install perimeter joint sealants as specified in Division 07 Section "Joint Sealants" to produce weathertight installation.

3.03 ERECTION TOLERANCES

- A. Install aluminum-framed systems to comply with the following maximum erection tolerances:
1. Location and Plane: Limit variation from true location and plane to **1/8 inch in 12 feet**; **1/4 inch** over total length.
 2. Alignment:
 - a. Where surfaces abut in line, limit offset from true alignment to **1/16 inch**.
 - b. Where surfaces meet at corners, limit offset from true alignment to **1/32 inch**.
- B. Diagonal Measurements: Limit difference between diagonal measurements to **1/8 inch**.

3.04 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections.
- B. Testing Services: Testing and inspecting of representative areas to determine compliance of installed systems with specified requirements shall take place as follows and in successive phases as indicated on Drawings. Do not proceed with installation of the next area until test results for previously completed areas show compliance with requirements.
1. Structural-Sealant Compatibility and Adhesion: Structural sealant shall be tested according to recommendations in ASTM C 1401.
 - a. Destructive Test Method A, "Hand Pull Tab (Destructive)," in ASTM C 1401, Appendix X2, shall be used.
 - 1) A minimum of four areas on each building face shall be tested.
 - 2) Repair installation areas damaged by testing.

2. Structural-Sealant Glazing Inspection: After installation of aluminum-framed systems is complete, structural-sealant glazing shall be inspected and evaluated according to recommendations in ASTM C 1401.
 3. Air Infiltration: Areas shall be tested for air leakage of 1.5 times the rate specified for laboratory testing under "Performance Requirements" Article, but not more than 0.09 cfm/sq. ft. of fixed wall area when tested according to ASTM E 783 at a minimum static-air-pressure difference of 1.57 lbf/sq. ft.
 4. Water Spray Test: Before installation of interior finishes has begun, a minimum area of 75 feet by 1 story of aluminum-framed systems designated by Architect shall be tested according to AAMA 501.2 and shall not evidence water penetration.
- C. Repair or remove work if test results and inspections indicate that it does not comply with specified requirements.
 - D. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
 - E. Aluminum-framed assemblies will be considered defective if they do not pass tests and inspections.
 - F. Prepare test and inspection reports.

3.05 ADJUSTING

- A. Adjust operating entrance door hardware to function smoothly as recommended by manufacturer.
 1. For entrance doors accessible to people with disabilities, adjust closers to provide a 3-second closer sweep period for doors to move from a 70-degree open position to 3 inches from the latch, measured to the leading door edge.

END OF SECTION 08 41 13

SECTION 08 41 23**ALUMINUM-FRAMED INTERIOR STOREFRONTS****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section Includes:
 - 1. Non-thermal interior storefront framing.
- B. Related Requirements:
 - 1. Section 08 41 13 "Aluminum-Framed Storefronts And Fixed Windows" for exterior storefront systems.
 - 2. Section 08 41 15 "Aluminum-Framed Manual Swing Entrance Doors" for doors installed in aluminum framed interior storefront.

1.03 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
- B. LEED Submittals:
 - 1. Product Data for Credit IEQ 4.1: For glazing sealants used inside the weatherproofing system, documentation including printed statement of VOC content.
- C. Shop Drawings: For aluminum-framed interior storefronts. Include plans, elevations, sections, full-size details, and attachments to other work.
- D. Samples for Verification: For each type of exposed finish required, in manufacturer's standard sizes.
- E. Fabrication Sample: Of each vertical-to-horizontal intersection of assemblies, made from 12-inch lengths of full-size components and showing details of the following:
 - 1. Joinery, including concealed welds.
 - 2. Anchorage.
 - 3. Glazing.

1.05 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.

- B. Source quality-control reports.
- C. Field quality-control reports.
- D. Sample Warranties: For special warranties.

1.06 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For aluminum-framed storefronts to include in maintenance manuals.

1.07 QUALITY ASSURANCE

- A. Sole-source Requirement: Provide Aluminum-Framed Storefronts and Fixed Windows, Aluminum Framed Manual Swing Entrance Doors, and Aluminum-framed Interior Storefront by the same manufacturer.
- B. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.
- C. Product Options: Information on Drawings and in Specifications establishes requirements for aesthetic effects and performance characteristics of assemblies. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction.
 - 1. Do not change intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If changes are proposed, submit comprehensive explanatory data to Architect for review.

1.08 WARRANTY

- A. Special Warranty: Installer agrees to repair or replace components of aluminum-framed storefronts that do not comply with requirements or that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures including, but not limited to, excessive deflection.
 - b. Deterioration of metals, metal finishes, and other materials beyond normal wear.
 - c. Failure of operating components.
 - 2. Warranty Period: Two years from date of Substantial Completion.
- B. Special Finish Warranty: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of factory-applied finishes within specified warranty period.
 - 1. Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
 - b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
 - 2. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design aluminum-framed interior storefronts.
- B. General Performance: Comply with performance requirements specified, as determined by testing of aluminum-framed storefronts representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.
 - 1. Aluminum-framed storefronts shall withstand movements of supporting structure including, but not limited to, story drift, twist, column shortening, long-term creep, and deflection from uniformly distributed and concentrated live loads.
 - 2. Failure also includes the following:
 - a. Thermal stresses transferring to building structure.
 - b. Glass breakage.
 - c. Noise or vibration created by wind and thermal and structural movements.
 - d. Loosening or weakening of fasteners, attachments, and other components.
 - e. Failure of operating units.
- C. Deflection of Framing Members: At design wind pressure, as follows:
 - 1. Deflection Normal to Wall Plane: Limited to edge of glass in a direction perpendicular to glass plane not exceeding 1/175 of the glass edge length for each individual glazing lite or an amount that restricts edge deflection of individual glazing lites to 3/4 inch, whichever is less.
 - 2. Deflection Parallel to Glazing Plane: Limited to 1/360 of clear span or 1/8 inch, whichever is smaller.

2.02 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Trifab VG 450 (non-thermal, 2 inch sightline). Other manufacturers may be considered, provided the sole-source requirement is met.

2.03 FRAMING

- A. Framing Members: Manufacturer's extruded- or formed-aluminum framing members of thickness required and reinforced as required to support imposed loads.
 - 1. Construction: Nonthermal.
 - 2. Glazing System: Retained mechanically with gaskets on four sides.
 - 3. Glazing Plane: Front.
 - 4. Finish: Clear anodic finish.
 - 5. Fabrication Method: Field-fabricated stick system.
- B. Backer Plates: Manufacturer's standard, continuous backer plates for framing members, if not integral, where framing abuts adjacent construction.
- C. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.

D. Materials:

1. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
 - a. Sheet and Plate: [ASTM B 209](#).
 - b. Extruded Bars, Rods, Profiles, and Tubes: [ASTM B 221](#).
 - c. Extruded Structural Pipe and Tubes: [ASTM B 429/B 429M](#).
 - d. Structural Profiles: [ASTM B 308/B 308M](#).

2.04 ACCESSORIES

- A. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.
 1. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
 2. Reinforce members as required to receive fastener threads.
- B. Bituminous Paint: Cold-applied asphalt-mastic paint complying with SSPC-Paint 12 requirements except containing no asbestos, formulated for [30-mil](#) thickness per coat.

2.05 FABRICATION

- A. Form or extrude aluminum shapes before finishing.
- B. concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.
- C. Fabricate components that, when assembled, have the following characteristics:
 1. Profiles that are sharp, straight, and free of defects or deformations.
 2. Accurately fitted joints with ends coped or mitered.
 3. Physical isolation of glazing from framing members.
 4. Accommodations for mechanical movements of glazing and framing to maintain required glazing edge clearances.
 5. Provisions for field replacement of glazing from interior.
 6. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.
- D. Mechanically Glazed Framing Members: Fabricate for flush glazing without projecting stops.
- E. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

2.06 ALUMINUM FINISHES

- A. Clear Anodic Finish: [AAMA 611](#), [AA-M12C22A31](#), Class II, 0.010 mm or thicker.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine areas, with Installer present, for compliance with requirements for

installation tolerances and other conditions affecting performance of the Work.

- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Prepare surfaces that are in contact with structural sealant according to sealant manufacturer's written instructions to ensure compatibility and adhesion. Preparation includes, but is not limited to, cleaning and priming surfaces.

3.03 INSTALLATION

- A. General:

1. Comply with manufacturer's written instructions.
2. Do not install damaged components.
3. Fit joints to produce hairline joints free of burrs and distortion.
4. Rigidly secure nonmovement joints.
5. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.

- B. Metal Protection:

1. Where aluminum is in contact with dissimilar metals, protect against galvanic action by painting contact surfaces with materials recommended by manufacturer for this purpose or by installing nonconductive spacers.
2. Where aluminum is in contact with concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.

- C. Install components plumb and true in alignment with established lines and grades.

- D. Install glazing as specified in Section 08 80 00 "Glazing."

3.04 ERECTION TOLERANCES

- A. Erection Tolerances: Install aluminum-framed storefronts to comply with the following maximum tolerances:

1. Plumb: 1/8 inch in 10 feet; 1/4 inch in 40 feet.
2. Level: 1/8 inch in 20 feet; 1/4 inch in 40 feet.
3. Alignment:
 - a. Where surfaces abut in line or are separated by reveal or protruding element up to 1/2 inch wide, limit offset from true alignment to 1/16 inch.
 - b. Where surfaces are separated by reveal or protruding element from 1/2 to 1 inch wide, limit offset from true alignment to 1/8 inch.
 - c. Where surfaces are separated by reveal or protruding element of 1 inch wide or more, limit offset from true alignment to 1/4 inch.
4. Location: Limit variation from plane to 1/8 inch in 12 feet; 1/2 inch over total length.

END OF SECTION 08 41 13

SECTION 08 62 14**TUBULAR DAYLIGHTING SYSTEM****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section includes the following:
1. Tubular daylighting system, consisting of roof dome, reflective tube, and diffuser assembly; configuration as indicated on the drawings.
 2. Accessories.
- B. Related Section:
1. Division 07 roofing sections for flashing of skylight base.
 2. Division 26 Sections for Equipment Wiring: Electrical connections.

1.03 PERFORMANCE REQUIREMENTS

- A. Completed tubular daylighting system assemblies shall be capable of meeting the following performance requirements:
1. Air Infiltration Test: Air infiltration will not exceed .30 cfm/sf aperture with a pressure delta of 1.57 psf across the tube when tested in accordance with ASTM E 283.
 2. Water Resistance Test: No uncontrolled water leakage at 16.5 psf pressure differential with water rate of 5 gallons/hours/sf when tested in accordance with ASTM E 331.
 3. Uniform Load Test:
 - a. No breakage, permanent damage to fasteners, hardware parts, or damage to make system inoperable or cause permanent deflection of any section in excess of 1 percent of its span at a Positive Load of 110 psf or Negative Load of 60 psf.
 - b. All units shall be tested with a safety factor of 3 for positive pressure and 2 for negative pressure, acting normal to plane of roof in accordance with ASTM E 330.
 4. Testing:
 - a. Class B Burning Brand – The burning brand shall self-extinguish without transferring the fire to the dome Per: U.B.C. Standard 15-2 Class B Burning Brand Test. See ASTM E 108 and UL 790.
 - b. Self-Ignition Temperature - Greater than 650 degrees F Per: U.B.C. Standard 26-6. See ASTM D-1929-68 (1975).
 - c. Smoke Density - Rating no greater than 75 Per: U.B.C. Standard 26-5. (See ASTM D-2843-70) or no greater than 450 Per U.B.C. 8-1 (See ASTM

- Standard E 84-91A) in way intended for use.
- d. Rate of Burn - Minimum Burning Rate: 2.5 inches/min Classification CC-2: U.B.C. Standard 26-7. See ASTM D 635-74.

1.04 SUBMITTALS

- A. Product Data: Manufacturer's data sheets on each product to be used, including:
 1. Preparation instructions and recommendations.
 2. Storage and handling requirements and recommendations.
 3. Installation methods.
- B. Shop Drawings. Submit shop drawings showing layout, profiles and product components, including anchorage, flashings and accessories.
- C. Verification Samples: As requested by Architect.
- D. Test Reports: Independent testing agency or evaluation service reports verifying compliance with specified performance requirements.
- E. LEED Submittals: Provide documentation of how the requirements of Credit will be met:
 1. List of Daylight Credits available for the products specified.
 2. Data on Energy Optimization Performance Credits for the products specified.
 3. List of proposed materials with recycled content. Indicate post-consumer recycled content and pre-consumer recycled content for each product having recycled content.
 4. Product data and certification letter indicating percentages by weight of post-consumer and pre-consumer recycled content for products having recycled content.
 - a. Data on Regional Credits which may be available for the project location.
 5. Data on Perimeter and Non-Perimeter Controllability of Systems for use of Daylight Dimmer option with the products specified.
 6. Data on potential Innovation in Design Credits which may be available for the innovative use of the products specified.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Engaged in manufacture of tubular skylights for minimum 10 years.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Store products in manufacturer's unopened packaging until ready for installation.
- B. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

1.07 PROJECT CONDITIONS

- A. Maintain environmental conditions (temperature, humidity, and ventilation) within

limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

1.08 WARRANTY

- A. Tubular Daylighting System: Manufacturer's standard warranty for 10 years.
- B. Electrical Parts: Manufacturer's standard warranty for 5 years, unless otherwise indicated.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturer: Solatube International, Inc.

2.02 TUBULAR DAYLIGHTING SYSTEM

- A. Tubular Daylighting System General : Transparent roof-mounted skylight dome and self-flashing curb, reflective tube, and ceiling level diffuser assembly, transferring sunlight to interior spaces; complying with ICBO/ICC AC-16.
- B. Skyvault Series: Solatube Model M74 Daylighting System:
 - 1. Roof Dome Assembly: Transparent, UV and impact resistant dome with flashing base supporting dome and top of tube.
 - a. Outer Dome Glazing: Type DA, 0.125 inch minimum thickness impact resistant injection molded acrylic classified as CC2 material and meeting characteristics of DR-101 blend. Visible light transmission minimum 92 percent.
 - b. Inner Dome Glazing: Type DAI, 0.115 inch (3 mm) minimum thickness acrylic classified as CC2 material.
 - 2. Flashing Base: One piece, seamless, leak-proof flashing functioning as base support for dome and top of tube.
 - a. Base Material: Sheet steel, corrosion resistant, meeting ASTM A 653/A 653M or ASTM A 463/A 463M, 0.028 inch thick.
 - b. Base Style: Type FC, Curb cap, with inside dimensions of 27 inches by 27 inches to cover curb.
 - c. Curb Insulator: Type CI, Thermal isolation material for use at curb base.
 - 3. Dome Ring: Attached to top of base section; 0.090 inch nominal thickness injection molded high impact acrylic; to prevent thermal bridging between base flashing and tubing and channel condensed moisture out of tubing.
 - 4. Reflective Extension Tube: Aluminum sheet, thickness 0.015 inch.
 - a. Interior Finish: Spectralight Infinity high reflectance specular finish on exposed reflective surface. Visible spectrum greater than 99 percent. Total solar spectrum less than 93 percent.
 - b. Color: a* and b* (defined by CIE L*a*b* color model) shall not exceed plus 2 or be less than minus 2 as determined in accordance to ASTM E 308.

- c. Tube Diameter: Approximately 21 Inches
5. Reflective 30 degree Adjustable tube: Aluminum sheet, thickness .015 inch.
 - a. Interior Finish: Spectralight Infinity high reflectance specular finish on exposed reflective surface. Visible spectrum greater than 99 percent. Total solar spectrum less than 93 percent.
6. Ceiling Ring: Injection molded impact resistant acrylic. Nominal thickness is 0.110 inches.
7. Dress Ring: Injection molded impact resistant acrylic. Nominal thickness is 0.100 inches Prevents air infiltration and condensation from attic spaces.
8. Diffuser Assemblies for Tubes Penetrating Ceilings: Ceiling mounted box transitioning from round tube to square ceiling assembly, supporting light transmitting surface at bottom termination of tube; 23.8 inches by 23.8 inches square frame to fit standard suspended ceiling grids or hard ceilings.
 - a. Round to square transition box made of opaque polymeric material, classified as CC2, Class C, 0.110 inch thick:
 - b. Lens: Type L2 Prismatic lens design to maximize light output and diffusion with extruded aluminum frame and EPDM foam seal to minimize condensation and bug, dirt and air infiltration per ASTM E 283. Visible Light Transmission shall be greater than 90 percent at 0.100 inches (2.5 mm) thick. Classified as CC2.
9. Accessories:
 - a. Daylight Dimmer: Type D, Electro-mechanically actuated daylight valve; for universal input voltages ranging between 90 and 277 V at 50 or 60 Hz; actuator rated at 0.1 amp per unit; controlled by low voltage, series circuited, 4 conductor, size 22 cable, and low voltage DC DP/DT switch; providing daylight output between 2 and 100 percent. Provided with dimmer switch and cable.
 - 1) Switch: Type SW, Low voltage switch (white) required to operate Daylight Dimmer. Note: only one switch is required per set of synchronously controlled dimmers.
 - 2) Cable: Type CA, Two conductor low voltage cable (500 ft.)
 - b. Wire Suspension Kit: Type E, Use the wire suspension kit when additional bracing to the structure is required

2.03 ACCESSORIES

- A. Fasteners: Same material as metals being fastened, non-magnetic steel, non-corrosive metal of type recommended by manufacturer, or injection molded nylon.
- B. Suspension Wire: Steel, annealed, galvanized finish, size and type for application and ceiling system requirement.
- C. Sealant: Polyurethane or copolymer based elastomeric sealant as provided or recommended by manufacturer.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Do not begin installation until substrates have been properly prepared.
- B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.02 PREPARATION

- A. Clean surfaces thoroughly prior to installation.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.03 INSTALLATION

- A. Install in accordance with manufacturer's printed instructions.
- B. After installation of first unit, field test to determine adequacy of installation. Conduct water test in presence of Owner, Architect, or Contractor, or their designated representative. Correct if needed before proceeding with installation of subsequent units.

3.04 PROTECTION

- A. Protect installed products until completion of project.
- B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION 08 62 14

**SECTION 087100
DOOR HARDWARE****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Furnish and install all commercial door hardware and electrified door hardware as shown on the Drawings or specified herein, or as required to complete the Work.
- B. Intent of Hardware Groups
 - 1. The following schedule of hardware sets shall be considered a guide only, and the supplier is cautioned to refer to general conditions, special conditions, and the preamble of this section. It shall be the hardware supplier's responsibility to furnish all required hardware.
 - 2. Where items of hardware aren't definitely or correctly specified and are required for completion of the Work, a written statement of such omission, error, or other discrepancy shall be sent to the Architect, prior to date specified for receipt of bids for clarification by addendum; or, furnish such items in the type and quality established by this specification, and appropriate to the service intended.
- C. Related sections:
 - 1. Division 1 – General Requirements
 - 2. Division 8 – Steel Doors and Frames
 - 3. Division 8 – Wood Doors
 - 4. Division 8 – Aluminum Doors and Frames
 - 5. Division 8 – Special Doors
 - 6. Division 26 – Electrical
 - 7. Division 28 – Access Control and Security Intrusion

1.03 REFERENCES

- A. Use date of standard or code in effect as of Bid date.
- B. State and Local Codes including Authority Having Jurisdiction.
- C. ANSI/BHMA A156 – Builders Hardware Manufacturers Association Builders Hardware Standards
- D. NFPA – National Fire Protection Association
 - 1. NFPA 80 – Fire Doors and Windows
 - 2. NFPA 105 – Smoke and Draft Control Door Assemblies
 - 3. NFPA 252 - Standard Methods of Fire Tests of Door Assemblies.
 - 4. NFPA 101 – Life Safety Code.

- E. UL – Underwriters Laboratories
 - 1. UL10C – Fire Tests of Door Assemblies (Positive Pressure)
 - 2. UL 1784 - Air Leakage Tests of Door Assemblies
- F. ANSI A117.1 – Accessible and Usable Buildings and Facilities
- G. ADA – Americans with Disabilities Act
- H. DHI – Door and Hardware Institute
- I. SDI – Steel Door Institute
- J. WDMA – Window and Door Manufacturers Association
- K. NEC – National Electrical Code

1.04 SUBMITTALS

- A. Submit copies of the finish hardware shop drawings in accordance with Division 1, General Requirements.
- B. Product Data: Submit manufacturer's complete product literature for specified hardware items, detailed installation diagrams and instructions, including:
 - 1. Preparation instructions and recommendations.
 - 2. Storage and handling requirements and recommendations.
 - 3. Installation methods.
- C. Door Hardware Schedule: Prepared by or under the supervision of the supplier's Architectural Hardware Consultant, detailing fabrication and assembly of door hardware, as well as procedures and diagrams. Coordinate the final Door Hardware Schedule with doors frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.
 - 1. Check specified hardware for suitability and adaptability to details and surrounding conditions. Indicate unsuitable or incompatible items and proposed substitutions in hardware schedule.
 - 2. Format: Comply with scheduling sequence and vertical format in DHI's "Sequence and Format for the Hardware Schedule."
 - 3. Organization: Organize the Door Hardware Schedule into door hardware sets indicating complete designations of every item required for each door or opening.
 - 4. Organize door hardware sets in same order as in the Door Hardware Schedule at the end of Part 3.
 - 5. Content: Include the following information:
 - a. Type, style, function, size, label, hand, degree of swing, and finish of each door hardware item.
 - b. Manufacturer of each item.
 - c. Fastenings and other pertinent information.
 - d. Location of each door hardware set, cross-referenced to Drawings, both on floor plans and in door and frame schedule.

- e. Explanation of abbreviations, symbols, and codes contained in schedule.
 - f. Mounting locations for door hardware.
 - g. Door and frame sizes and materials.
6. Electrified Hardware Drawings:
- a. Submit elevation drawings showing relationship of all electrical hardware components to door and frame prior to electrical rough-in. Indicate number and gage of wires required.
 - b. Include wiring drawing showing point to point wire hook up for all components.
 - c. Include system operations descriptions for each type of opening; describe each possible condition.
- D. Keying Schedule: Prepared by or under the supervision of Architectural Hardware Consultant, detailing Owner's final keying instructions for locks. Include schematic keying diagram and index each key set to unique door designations. Keying Schedule: Per DHI manual "Keying Procedures, Systems, and Nomenclature".
- E. Qualification Data: For Installer, Supplier, and Architectural Hardware Consultant. Compliance with this Section shall include letters of certification. Certifications shall be submitted for approval with and be incorporated with hardware schedule submittal. Submittals will not be considered without the certifications.
- F. Submittal Sequence: Submit the final Door Hardware Schedule at earliest possible date, particularly where approval of the Door Hardware Schedule must precede fabrication of other work that is critical in the Project construction schedule. Include Product Data, Samples, Shop Drawings of other work affected by door hardware, and other information essential to the coordinated review of the Door Hardware Schedule.
- G. Operations and maintenance manuals:
1. Upon completion of construction and building turnover, furnish two (2) complete maintenance manuals to the owner. Manuals to include the following items:
 - a. Approved hardware schedule, catalog cuts and keying schedule.
 - b. Hardware installation and adjustment instructions.
 - c. Manufacturer's written warranty information.
 - d. As installed "Wiring Diagrams" for each opening connected to power, both low voltage and 110 volts.
 - e. One complete set of special tools required for maintenance and adjustment of hardware, including changing of cylinders.

1.05 QUALITY ASSURANCE

A. Substitutions:

1. All substitution requests must be submitted within the procedures and time frame as outlined in Division 1, General Requirements. Approval of products is at the discretion of the architect and their consultant.
2. Items listed with no substitute manufacturers have been requested by Owner to

meet existing standards.

B. Requirements of Regulatory Agencies:

1. Furnish finish hardware to comply with the requirements of laws, codes, ordinances, and regulations of the governmental authorities having jurisdiction where such requirements exceed the requirements of the Specifications. Furnish finish hardware to comply with the requirements of the American National Standards for Making Buildings and Facilities Accessible and Usable by Physically Handicapped People ICC/ANSI A117.1) and to comply with Americans with Disabilities Act (ADA).
2. Doors to stairs (other than exit stairs), loading platforms, boiler rooms, stages and doors serving other hazardous locations shall have knurled or other similar approved marking of door lever handles or cross bars in accordance with local building codes.

C. Installer Qualifications: An experienced installer with five (5) years documented experience who has completed door hardware similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

D. Supplier Qualifications: Company specializing in the supply of door hardware with five (5) years documented experience and an Architectural Hardware Consultant (AHC) to properly handle, detail and service hardware in a satisfactory manner. Architectural Hardware Consultant shall be available during the course of the Work to consult with Contractor, Architect, Hardware Consultant, and Owner about door hardware and keying.

1. Scheduling Responsibility: Preparation of door hardware and keying schedules.
2. Engineering Responsibility: Preparation of data for electrified door hardware, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.
3. Hardware supplier shall be a certified direct distributor and be a full sales and service organization for the manufacturer's listed. Compliance with this Section shall include letters of certification from the manufacturers stating the hardware supplier is a factory direct authorized distributor. Certifications shall be submitted for approval with and be incorporated with hardware schedule submittal. Submittals will not be considered without the certifications.
4. Supplier shall have warehousing facilities in Project's vicinity.

E. Architectural Hardware Consultant Qualifications: A person who is currently certified by the Door and Hardware Institute as an Architectural Hardware Consultant and who is experienced in providing consulting services for door hardware installations that are comparable in material, design, and extent to that indicated for this Project.

1. Electrified Door Hardware Consultant Qualifications: A qualified Architectural Hardware Consultant who is experienced in providing consulting services for electrified door hardware installations.

F. Source Limitations: Obtain each type and variety of door hardware from a single

manufacturer, unless otherwise indicated.

1. Provide electrified door hardware from same manufacturer as mechanical door hardware, unless otherwise indicated. Manufacturers that perform electrical modifications and that are listed by a testing and inspecting agency acceptable to authorities having jurisdiction are acceptable.
- G. Fire-Rated Door Assemblies: Provide door hardware for assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to NFPA 252 and UL10C. Project requires door assemblies and components that are compliant with positive pressure and S-label requirements. Specifications must be cross-referenced and coordinated with door manufacturers to ensure that total opening engineering is compatible with UL10C Standard for Positive Pressure Fire Tests of Door Assemblies. Provide proper latching hardware, non-flaming door closers, approved-bearing hinges, plus resilient and required intumescent seals if not furnished with wood door.
- H. Templates: Furnish a complete list and suitable templates, together with finish hardware schedule to contractor, for distribution to necessary trades supplying materials to be prepped for finish hardware.
- I. Keying Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination." In addition to Owner, Construction Manager, Contractor, and Architect, conference participants shall also include Suppliers Architectural Hardware Consultant and Owner's security consultant. Incorporate keying conference decisions into final keying schedule after reviewing door hardware keying system including, but not limited to, the following:
1. Review of all lock functions.
 2. Function of building, flow of traffic, purpose of each area, degree of security required, and plans for future expansion.
 3. Preliminary key system schematic diagram.
 4. Requirements for key control system.
 5. Address for delivery of keys.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Marking and packaging:

1. Properly package and mark items according to the approved hardware schedule, complete with necessary screws and accessories, instructions and installation templates for spotting mortising tools.
2. Packaging of door hardware is the responsibility of the supplier. As hardware supplier receives material from various manufacturers, sort and repackage in containers clearly marked with appropriate hardware set and door numbers to match the approved hardware schedule. Two or more identical sets may be packed in same container.

B. Delivery:

1. Deliver all hardware to the project site; direct factory shipments are not allowed unless agreed upon beforehand.
2. No keys, other than construction master keys and/or temporary keys are to be packed in boxes with the locks.
3. Deliver keys and permanent cores to Owner by registered mail or overnight package service.
4. Check deliveries against accepted list and provide receipt for them

C. Storage:

1. Provide secure lock-up for door hardware delivered to the Project, but not yet installed. Control handling and installation of hardware items that are not immediately replaceable so that completion of work will not be delayed by hardware losses both before and after installation.

1.07 PROJECT CONDITIONS

- A. Maintain environmental conditions (temperature, humidity and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

1.08 COORDINATION

- A. Supplier shall coordinate the following items with the General Contractor and related trades.

1. Coordinate work of this Section with other directly affected Sections involving manufacture of any internal reinforcement for door hardware. Furnish hardware templates to door fabricators for factory preparation to receive hardware.
2. Furnish hardware items of proper design for use on doors and frames of thicknesses, profile, swing, security, and other indicated requirements as necessary for proper function.
3. Coordinate solid blocking between studs of frame construction to support wall mounted items such as stops.
4. Electrical System Roughing-in: Coordinate layout and installation of electrified door hardware with connections to power supplies, fire alarm system and detection devices and access control system. Electro-Mechanical Hardware requires meticulous coordination among:
 - a. Architect.
 - b. Electrical engineer.
 - c. Hardware supplier/contractor.
 - d. Electro-mechanical hardware supplier/contractor.
 - e. Frame supplier/contractor.
 - f. Electrical Contractor.
 - g. Security systems Contractor

- B. A hardware and keying conference is mandatory within 30 days of contract award.

- C. Use hardware consultant to check Shop Drawings for doors and entrances to confirm that adequate provisions will be made for proper hardware installation.

1.09 WARRANTY:

- A. General Warranty: Special warranties specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.
- B. Special Warranty: Written warranty, executed by manufacturer agreeing to repair or replace components of door hardware that fail in materials or workmanship within specified warranty period. Failures include, but are not limited to, the following:
 - 1. Structural failures including excessive deflection, cracking, or breakage.
 - 2. Faulty operation of operators and door hardware.
 - 3. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
- C. Warranty Period: One (1) year from date of Substantial Completion, unless otherwise indicated.
 - 1. Warranty Period for Manual Closers: Ten (10) years from date of Substantial Completion.
 - 2. Warranty Period for Locksets: Seven (7) years from date of Substantial Completion.
 - 3. Warranty Period for Mechanical Exit Devices: Three (3) years from date of Substantial Completion.

1.10 MAINTENANCE SERVICE

- A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.

1.11 COMMISSIONING:

- 1. Test door hardware operation with climate control system both at rest and while in full operation.
- 2. Test electrical and electronic hardware systems for satisfactory operation.
- 3. Test hardware interfaced with fire/life-safety system for proper operation and release.

1.12 EXTRA MATERIALS

- A. Deliver to Owner extra service materials from same production run as products installed. Package products with protective covering and identify with descriptive labels. Comply with Division 01 Closeout Submittals (Maintenance Materials) Section.
 - 1. Special Tools: Provide special wrenches and tools applicable to each different or special hardware component.
 - 2. Maintenance Tools: Provide maintenance tools and accessories supplied by hardware component manufacturer.
 - 3. Delivery, Storage and Protection: Comply with Owner's requirements for delivery,

storage and protection of extra materials.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Furnish each category with the products of only one manufacturer unless specified otherwise; this requirement is mandatory whether various manufacturers are listed or not.
- B. Provide the products of manufacturer designated or if more than one manufacturer is listed, the comparable product of one of the other manufacturers listed. Where only one manufacturer or product is listed, it is understood that this is the owner's Building Standard and "no substitution" is allowed.

2.02 GENERAL HARDWARE REQUIREMENTS:

- A. Provide hardware materials and products of the best quality, free from imperfections and flaws in appearance, finish, or operational function.
- B. Refer to Hardware Schedule below for specific hardware items, designs, functions, sizes, and finishes.

2.03 HINGES

- A. Manufacturers:
 - 1. Ives
 - 2. McKinney
 - 3. Stanley
- B. General: Except for hinges and pivots to be installed entirely (both leaves) into wood doors and frames, provide only template-produced units.
- C. Hinges shall be five-knuckle design, ball bearing, as specified with NRP (non-removable pin) feature, at all reverse bevel doors with locksets.
- D. Hinge Base Metal: Unless otherwise indicated, provide the following:
 - 1. Exterior Hinges: Stainless steel with stainless-steel non-removable pin.
 - 2. Interior Hinges: Steel, with steel pin
 - 3. Hinges for Fire-Rated Assemblies: Steel, with steel pin.
- E. Quantity, regardless of quantities specified in the hardware schedule provide the following:
 - 1. 2 - hinges per leaf for openings through 60 inches (1524 mm) high.
 - 2. 1 - additional hinge per leaf for each additional 30 inches (762 mm) in height or fraction thereof.
- F. Size, provide the following:
 - 1. Doors up to 3'6": three ball bearing, standard weight, 0.134 gage, 4-1/2 inch by

- 4-1/2 inch (114 mm by 114 mm).
 - 2. Doors 3'-6" and over: three ball bearing, heavy weight, 0.190 gage, 5 inches x 4-1/2 inches (127 mm by 114 mm).
- G. Provide shims and shimming instructions for proper door adjustment.
- H. Electric Hinges:
- 1. Transfer power from door frame to edge of door.
 - 2. Provide sufficient number of concealed wires to accommodate electric function of specified hardware plus at least two extra wires as spares.
 - 3. Locate electric hinges at second hinge from bottom.
 - 4. Provide mortar guard for each electric hinge scheduled.
- I. Electric Power Transfer:
- 1. Manufacturers:
 - a. Von Duprin
 - 2. Transfer power from door frame to edge of door.
 - 3. Provide sufficient number of concealed wires to accommodate electric function of specified hardware.

2.04 DOOR BOLTS

- A. Manufacturers:
- 1. Ives
 - 2. Rockwood
 - 3. Trimco
- B. Bolt Throw: Comply with testing requirements for length of bolts required for labeled fire doors, and as follows:
- 1. Mortise Flush Bolts: Minimum 3/4-inch (19-mm) throw.
- C. Manual Flush Bolts: designed for mortising into door edge.
- D. Automatic and Self-Latching Flush Bolts: designed for mortising into door edge.
- E. Surface bolt locks automatically when throw, can be released only by pressing knob toward door while retracting. Provide strikes as required.
- F. Locate centerline of manual top bolt not more than 78 inches (1981 mm) from finished floor.
- G. Dust Proof Strikes - furnish with all flush bolts.

2.05 COORDINATORS

- A. Manufacturers:

1. Ives
 2. Rockwood
 3. Trimco
- B. Provide coordinator for labeled pairs of doors equipped with automatic flush bolts and those with vertical rod/mortise lock fire exit device combinations with astragals.
- C. Provide filler bars for total opening width, closer mounting brackets, carry bars, and special preparation for top latches where applicable.

2.06 LOCKSETS AND LATCHSETS

- A. Manufacturers:
1. Schlage L9000/ND
 2. Best 40H/9K
 3. Sargent 8800/10 Line
- B. Latches and Locks for Means of Egress Doors: Comply with NFPA 101. Doors shall not exceed 15 lbf (67 N) to release the latch. Locks shall not require the use of a key, tool, or special knowledge for operation from the egress side.
- C. Function numbers as listed in sets.
- D. Heavy duty cylindrical type:
1. Provide cylindrical locksets that comply with ANSI A156.2, Series 4000, Grade 1; tested to exceed 3,000,000 cycles. Functions as listed in Hardware Sets.
 2. Provide cylindrical locksets that meet ANSI A117.1, Accessibility Code.
 3. Provide cylindrical locksets that meet UL A label; to have a minimum listing for single doors 4' x 8'
 4. Levers are to be plated to match BHMA finishes.
 5. Thru-bolts to be a minimum of ¼" in diameter.
 6. Latchbolt to be steel with minimum ½" throw deadlatch on keyed and exterior functions; ¾" throw anti-friction latchbolt on pairs of doors.
 7. Lockset shall accept large format interchangeable core cylinder.
 8. Lockset Trim: Basis of Design: Schlage Rhodes
- E. Mortise type:
1. Provide mortise locksets that comply with ANSI A156.13, Series 1000, Operational Grade 1 and Security Grade 2 with all standard trims.
 2. Provide mortise locksets that comply with UL10C and UBC 7-2 positive pressure requirements.
 3. Lock components to be manufactured of zinc dichromate plated steel. .
 4. Lock components to incorporate a spring loaded fusible link for Fire/Life Safety. Manufacturers utilizing gravity, fusible link are acceptable.
 5. Latchbolts to have a standard 2 ¾" backset with a full ¾" throw.

6. Deadbolts to be 1 3/4" total length; have standard 1" throw with a minimum 3/4" internal engagement when fully extended.
7. Spindles to be independent, designed to "break-away" at a maximum of 75psi torque.
8. Strikes to be non-handed and bridged to ensure dead latching. Manufacturers utilizing fillers of any kind for deadlatch engagement are not acceptable.
9. Thumbturn and back-plate to be manufactured from castings and comply with ANSI 117 accessibility standard.
10. Electric operation: Manufacturer-installed continuous duty solenoid.
11. Lockset Trim: Basis of Design: Schlage 06A

F. Strikes:

1. Provide strikes with extended lips where required to protect trim from being marred by latch bolt. Provide strike lips that do not project more than 1/8" beyond doorframe trim at single doors and have 7/8" lip to center at pairs of 1-3/4" doors. Provide wrought box strikes on all locks.

G. Hardware supplier shall verify all lock functions with Owner prior to ordering material.

2.07 CYLINDERS AND KEYING

A. Manufacturers:

1. Schlage
2. Best
3. Sargent

B. Keying schedule: The supplier's Factory Authorized Service Center shall meet with the Owner to finalize keying requirements and obtain keying instructions in writing. All cylinders shall be keyed by Service Center, combined in sets or subsets, masterkeyed or great grandmaster keyed, as directed by Owner.

C. Permanent Cores: Manufacturer's standard; finish face to match lockset; interchangeable cores.

D. Construction Cores: Provide construction cores that are replaceable by permanent cores.

1. The Owner or Owner's Security Agent in conjunction with the service center shall remove construction cores and install final cores.

E. Keying System: Both the cylinders and key blanks shall be protected from unauthorized manufacture and distribution by the manufacturer's United States patents.

F. Key System: Lock manufacturers patented, restricted keyway. Key blanks available only from factory-direct sources, not available from after-market key blank manufacturers.

- G. Keys: Provide nickel-silver keys permanently inscribed with a visual key control number and "DO NOT DUPLICATE" notation. Furnish keys in the following quantities:
1. Cylinder Change Keys: Three.
 2. Master Keys: Five.
 3. Grand Master Keys: Five.
 4. Great-Grand Master Keys: Five.
 5. Temporary construction keys: Twenty.
 6. Construction control keys: Two.
- H. Deliver all permanent keys, security cores, and other security keys direct to Owner from Service Center a minimum of thirty (30) days prior to completion by secure courier return receipt requested.

2.08 EXIT DEVICES AND MULLIONS

- A. Exit devices for Means of Egress Doors: Comply with NFPA 101. Doors shall not exceed 15 lbf (67 N) to release the latch. Locks shall not require the use of a key, tool, or special knowledge for operation from the egress side.
- B. Manufacturers:
1. Von Duprin
 2. Precision
 3. Detex
- C. Rim devices:
1. Exit devices shall be touchpad style plated to the standard architectural finishes to match the balance of the door hardware.
 2. Mechanism case or housing shall have an average minimum thickness of .140".
 3. Touchpad shall extend a minimum of one half of the door width. Devices shall be push through type touch pad design with a straight or horizontal motion to eliminate pinch points. The angular motion type pad with end cavity exposed when depressed is unacceptable. Touch pad have a minimum height of 2-3/16" Plastic is not acceptable at the touch pad.
 4. All latchbolts to be deadlatching type, with a self-lubricating coating to reduce wear. Plated latch bolts are unacceptable.
 5. Lever trim for exit devices shall be vandal-resistant type, which will travel to a 90-degree down position when more than 35 pounds of torque are applied, and which can easily be re-set. Trim shall be heavy duty type and fastened by means of concealed welded lugs and thru bolts from the inside. Lever trim shall be forged brass with a minimum average thickness on the escutcheon of .130". Plate with pull shall be minimum average thickness of .090" and have forged pulls.
 6. Trim: as specified in sets, function numbers as listed in sets. Levers to match lockset design.
 7. Exit devices shall be UL listed panic exit hardware. All exit devices for fire rated openings shall be UL labeled fire exit hardware.
 8. Electrically Operated Devices: Single manufacturer source for electric latch retraction devices, electrically controlled trim, power transfers, power supplies,

- monitoring switches and controls.
9. Provide hex key or cylinder dogging on panic exit hardware as scheduled.
 10. Furnish glass bead kits for exit devices as required.
 11. Where RX and LX switches and used at exit devices hardware supplier shall confirm current draw with security contractor, low current (LC) option may be required.
 12. Through Bolts: For exit devices and trim on metal doors, non-fire-rated wood doors, fire-rated wood doors and fire-rated metal doors.

2.09 DOOR PULLS

- A. Manufacturers:
 1. Ives
 2. Rockwood
 3. Trimco
- B. Pull Hardware – as scheduled.

2.10 CLOSERS

- A. Manufacturers:
 1. LCN -4111
 2. Sargent -281
- B. Surface Closers:
- C. Door Closers:
 1. Closers shall conform to ANSI A156.4 Grade 1 and UL 10C
 2. Closers shall have fully hydraulic, full rack and pinion action with a high strength cast iron cylinder and one piece forged steel piston. Cylinder body to have 1½” piston diameter .
 3. Hydraulic fluid of a type requires no seasonal adjustments.
 4. Spring power shall be continuously adjustable over the full range of closer sizes, and allow for reduced opening force for the physically handicapped. .
 5. Size closers in compliance with requirements for accessibility for handicapped and recommendations of manufacturer. Comply with following maximum opening-force requirements:
 - a. Interior Hinged Doors: 5.0 lbs.
 - b. Fire Doors: Minimum opening force allowable by authorities having jurisdiction
 6. Closers will have Powder coating finish certified to exceed 100 hours salt spray testing by ETL, an independent testing laboratory used by BHMA for ANSI certification. Provide special rust inhibitor finish (SRI) where specified,
 7. Refer to door and frame details, furnish accessories such as drop plates, special templates, spacers and supports as required to correctly install door closers. Install closers to allow maximum degree of opening, position backcheck to activate well in advance of the stop position to cushion the opening swing and prevent door and frame damage. Do not us the door closer to stop door travel.
 8. Coordinate with door manufacturer that the top rail of the door is sized appropriately for the surface closer.

9. Doors swinging into exit corridors should provide for corridor clear width as required by applicable codes.
10. Install closers on room side of corridor doors, inside of exterior doors, and stair side of stairway doors.
11. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.

2.11 STOPS AND HOLDERS

A. Manufacturers:

1. Ives
2. Rockwood
3. Trimco

- B. Provide wall stops for doors, unless other type stops are scheduled or indicated. Where wall stops are not appropriate, provide overhead stops.
- C. Wrought, forged, or cast, approximately 2-1/2 inch diameter, convex or concave rubber center according to lock type, concealed fasteners.
- D. Silencers for Door Frames: Neoprene or rubber; fabricated for drilled-in application to frame.

2.12 OVERHEAD HOLDERS AND STOPS

A. Manufacturers:

1. Glynn Johnson
2. Rixson
3. ABH

- B. Type, function and fasteners shall be as specified. Size per manufacturer's selector chart. Plastic end caps, hold open mechanisms and shock blocks are not allowed. End caps must be finished same as balance of unit.
- C. When the overhead holder or stop is installed with a surface closer template closer according to work with the stop or holder. Provide mounting plates with closer is required.

2.13 KICK PLATES

A. Manufacturers:

1. Ives
2. Rockwood
3. Trimco

- B. Furnish .050 inches thick, 10" high x door width less 2" at single doors and less 1" at pairs on push side and 1" less door width on pull side, with counter sink holes for

fasteners. Where glass or louvers prevent this height, supply with height equal to height of bottom rail less 2".

- C. Fasteners: Manufacturer's standard machine or self-tapping screws.

2.14 THRESHOLDS

- A. Manufacturers:

1. National Guard Products
2. Pemko
3. Reese

- B. Accessibility Requirements: Where thresholds are indicated to comply with accessibility requirements, comply with the Accessibility Guidelines for Buildings and Facilities ANSI A117.1

1. Bevel raised thresholds with a slope of not more than 1:2.

- C. Type as listed in sets.

- D. Cope at jambs.

- E. Furnish full wall opening width when frames are recessed.

- F. Where thresholds occur at openings with one or more mullions, they shall be cut for the mullions and extended continuously for the entire opening.

- G. Furnish with non-ferrous Stainless Steel Screws and Lead Anchors.

2.15 DOOR SWEEPS

- A. Manufacturers:

1. National Guard Products
2. Pemko
3. Reese

- B. Type as listed in sets.

2.16 WEATHER-STRIPPING

- A. Manufacturers:

1. National Guard Products
2. Pemko
3. Reese

B. Door Gasketing: Provide continuous weather-strip gasketing on exterior doors and provide smoke, light, or sound gasketing on interior doors where indicated or scheduled. Provide non-corrosive fasteners for exterior applications and elsewhere as indicated. Type as listed in sets.

1. Apply to head and jamb stops.

C. Fire, Smoke and Draft Control Seals:

1. Smoke-Labeled Gasketing: Assemblies complying with NFPA 105 that are listed and labeled based on testing according to UL 1784.

2. Fire-Labeled Gasketing: Assemblies complying with NFPA 80 that are listed and labeled based on testing according to UL 10C.

3. Gaskets must comply with UL10C.

4. Intumescent seals shall be provided by the wood door manufacturer.

D. Where rain drips are specified in hardware groups, provide full frame width, unless detailed otherwise.

2.17 LATCH PROTECTORS

A. Manufacturers:

1. Ives

2. Rockwood

3. Trimco

B. Latch protectors shall be 13 gage stainless steel and be of the type required to work with the specified latch.

2.18 DOOR CONTACT (DOOR POSITION SWITCH)

A. Manufacturers:

1. Schlage Electronic

2. GE/Sentrol

3. SDC (Security Door Controls)

B. Concealed in frame and door.

C. Single Pole, double throw (SPDT) magnetic switch.

2.19 MISCELLANEOUS

A. Boxed Power Supplies: Modular unit in NEMA enclosure; filtered and regulated; voltage rating and type matching requirements of door hardware served; and listed and labeled for use with fire alarm systems.

B. Furnish items not categorized in the above descriptions but specified by manufacturer's names in Hardware Sets.

- C. Supplier shall review Security/Electrical Plan for locations of security equipment provided by others.

2.20 FABRICATION

- A. Base Metals: Produce door hardware units of base metal, fabricated by forming method indicated, using manufacturer's standard metal alloy, composition, temper, and hardness. Furnish metals of a quality equal to or greater than that of specified door hardware units and BHMA A156.18. Do not furnish manufacturer's standard materials or forming methods if different from specified standard.

2.21 FASTENERS

- A. Including, but not limited to, wood or machine screws, bolts, nuts, anchors, etc. of proper type, material, and finish required for installation of hardware.
- B. Use phillips head for exposed screws. Do not use aluminum screws to attach hardware.
- C. Provide self-tapping (TEC) screws for attachment of sweeps and stop-applied weatherstripping only.
- D. Through Bolts: For exit devices and surface closers on non-rated metal doors, fire-rated metal doors non-fire-rated wood doors, and fire-rated wood doors unless door blocking is provided:

2.22 FINISHES

- A. Generally, Dull Chrome, US26D / BHMA 626/652. Thresholds and Weatherstrip shall be Mill Finish Aluminum. Closers shall be Powder Coated Aluminum (BHMA 689). Trim and Flat Goods may be furnished in US32D (BHMA 630), Satin Stainless Steel.
- B. Provide finish for each item as indicated in sets.
- C. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

PART 3 - EXECUTION

3.01 ACCEPTABLE INSTALLERS:

- A. Factory trained and certified by the lock, closer and panic hardware manufacturers. Alternative: can demonstrate suitably equivalent competence and experience.

3.02 EXAMINATION

- A. Examine doors and frames as follows.
 - 1. Examine doors and frames, with Installer present, for compliance with requirements for installation tolerances, labeled fire door assembly construction, wall and floor construction, and other conditions affecting performance. Ensure

- that walls and frames are square and plumb before hardware installation.
2. Examine roughing-in for electrical power systems to verify actual locations of wiring connections before electrified door hardware installation.
 3. Proceed with installation only after unsatisfactory conditions have been corrected.
 4. Beginning of installation means acceptance of existing conditions.

3.03 PREPARATION

- A. Wood Doors: Comply with DHI A115-W series.
- B. Steel Doors and Frames: Comply with DHI A115 series.
 1. Surface-Applied Door Hardware: Drill and tap doors and frames according to ANSI/SDI A250.6-97.
- C. Door and Frame Manufacturer(s) to prepare doors and frames for electronic hardware furnished by Security Contractor.

3.04 INSTALLATION

- A. Install hardware in accordance with manufacturer's instructions and applicable requirements of SDI, WDMA, NFPA 80, BHMA, and DHI.
- B. Use the templates provided by hardware item manufacturer.
- C. Mounting Heights: Mount door hardware units at heights indicated in following applicable publications, unless specifically indicated or required to comply with governing regulations:
 1. Standard Steel Doors and Frames: DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."
 2. Wood Doors: DHI WDHS.3, "Recommended Locations for Architectural Hardware for Wood Flush Doors."
 3. Conform to ANSI A117.1 for positioning requirements for the handicapped.
 4. Where new hardware is to be installed near existing doors/hardware scheduled to remain, match locations of existing hardware.
- D. Process hardware for aluminum doors in accordance with DHI handbook, Processing Hardware for Custom Aluminum Doors and Frames.
- E. Wherever cutting and fitting are required to install hardware on surfaces which are to be painted or finished by others, coordinate removal, storage, and reinstallation or application of surface protections with finishing work specified in other Sections. Do not install surface-mounted items until finishes have been completed on the substrate. NOTE: NO POWER DRIVEN TOOLS SHALL BE USED FOR INSTALLATION OF LOCKSETS AND HARDWARE ON DOORS.
- F. Set units level, plumb, and true to line and location. Adjust and reinforce the attachment substrate as required for proper installation and operation.

- G. Drill and countersink units, which are not factory-prepared for anchorage fasteners. Space fasteners and anchors in accordance with referenced standards.
- H. Drill pilot holes for fasteners in wood doors and/or frames.
- I. Drawings typically depict doors at 90 degrees; doors will actually swing to maximum allowable. Template hardware for maximum allowable degree of swing.
- J. Gaskets: install jamb-applied gaskets before closers, overhead stops, rim strikes, etc. Install sweeps across bottoms of doors before astragals, cope sweeps around bottom pivots, trim astragals to tops of sweeps. Door Jambs must be cleaned of all dirt, grease, oil, solvents or solvent residue and dust before applying Pressure-Sensitive Adhesive backed Gasketing, Smoke Seal or Weatherstripping.
- K. Thresholds: Set thresholds for exterior and acoustical doors in full bed of sealant complying with requirements specified in Division 07 Section "Joint Sealants."
- L. Locate floor stops not more than 4 inches from the wall.
- M. Boxed Power Supplies: Locate power supplies as indicated or, if not indicated, above accessible ceilings. Verify location with Architect.

3.05 ADJUSTING

- A. Adjust and check each operating hardware item, and each door assembly to ensure proper operation and function. Lubricate moving parts with lubrication type recommended by manufacturer.
- B. Replace units, which cannot be adjusted and lubricated to operate freely and smoothly.
- C. Hardware damaged by improper installation or adjustment methods to be repaired or replaced to Owner's satisfaction.
- D. Make final adjustments and lubrication immediately prior to final acceptance.
 - 1. Door Closers: Closers shall be adjusted so that from an open position of 90 degrees, the time required to move the door to an open position of 12 degrees shall be 5 seconds minimum.
 - 2. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.
 - 3. Door control devices backcheck shall be properly located for protection of the door, frame, and applied hardware.

3.06 CLEANING AND PROTECTION

- A. Clean adjacent surfaces soiled by door hardware installation.
- B. Clean operating items as necessary to restore proper function and finish.
- C. Provide final protection and maintain conditions that ensure door hardware is without damage or deterioration at time of Substantial Completion.

3.07 FINAL ADJUSTMENT

- A. Wherever hardware installation is made more than one month prior to acceptance or occupancy of a space or area, return to the work during the week prior to acceptance or occupancy, and make final check and adjustment of all hardware items in such space or area. Clean operating items as necessary to restore proper function and finish of hardware and doors. Adjust door control devices to compensate for final operation of heating and ventilating equipment.

3.08 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain door hardware and door hardware finishes.

3.09 CLEANUP

- A. Remove protective material from hardware where present.
- B. Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

3.10 CONTINUED MAINTENANCE SERVICE

- A. Approximately six months after the acceptance of hardware in each area, the Installer shall return to the project and re-adjust every item of hardware to restore proper function of doors and hardware. Consult with and instruct Owner's personnel in recommended additions to the maintenance procedures. Replace hardware items that have deteriorated or failed due to faulty design, materials or installation of hardware units. Prepare a written report of current and predictable problems in the performance of the hardware.

3.11 ACCEPTANCE

- A. Warranty shall not start until Owner Acceptance. Acceptance shall be withheld until the following activities have been successfully completed:
 1. Commissioning per paragraph 1.12.
 2. Delivery and Acceptance of all Operations and maintenance manuals.
 3. Successful Final Test and Inspection of Security System.

3.12 DOOR HARDWARE SCHEDULE

- A. The following schedule is furnished for whatever assistance it may afford the Contractor; do not consider it as entirely inclusive. Should any particular door or item be omitted in any scheduled hardware heading, provide door or item with hardware same as required for similar purposes. Hardware supplier is responsible for handling and sizing all products as listed in the hardware heading. Quantities listed are for each pair of doors, or for each single door.
- B. Manufacturer Legend:
 1. (B/O) By Others

2. (GLY) Glynn Johnson
3. (IVE) Ives
4. (LCN) LCN
5. (NGP) National Guard Products
6. (SCE) Schlage Electronics
7. (SCH) Schlage
8. (VON) Von Duprin

HW SET# 001 - EXTERIOR (ALUM) W/AUTO OPERATOR

EACH TO HAVE:

1	EA	CONTINUOUS HINGE	DOOR MFG. STANDARD	628	B/O
1	EA	POWER TRANSFER	EPT10	689	VON
1	EA	ELEC PANIC HARDWARE	LX-RX-LC-QEL+-35A-NL-OP-388	626	VON
1	EA	RIM CYLINDER	20-057-ICX	626	SCH
1	EA	FSIC CORE	23-030 EV29 T	626	SCH
1	EA	90 DEG OFFSET PULL	8190 10" O	630	IVE
1	EA	OH STOP	100S	630	GLY
1	EA	SURF. AUTO OPERATOR	4642 TBWMS FLUSH CEILING MOUNT	689	LCN
2	EA	ACTUATOR, WALL MOUNT	8310-853T	630	LCN
1	EA	BOLLARD POST	8310-866	AL	LCN
1	SET	PERIMETER SEAL	DOOR MFR. STD.		B/O
1	EA	DOOR SWEEP	DOOR MFR. STD.		B/O
1	EA	THRESHOLD	DOOR MFR STD.	AL	B/O
1	EA	DOOR CONTACT	679-05HM	BLK	SCE
1	EA	POWER SUPPLY	PS902 900-BBK 900-2RS	LGR	SCE
1	EA	CARD READER	FURNISHED IN DIV 28		B/O

OPERATION:

- 1) ENTRY BY PRESENTING VALID CREDENTIAL AT READER TO RETRACT LATCH ON ACTIVE LEAF PANIC; THEN PRESS ACTUATOR BUTTON FOR AUTOMATIC OPENING.
- 2) INACTIVE LEAF PANIC HAS BUILT-IN REQUEST TO EXIT SWITCH.
- 3) PANIC DEVICES ALLOW FREE EGRESS AT ALL TIMES.

TEMPLATE OVERHEAD STOP AT 110 DEGREES.

HW SET# 002 - VESTIBULE

EACH TO HAVE:

1	EA	CONTINUOUS HINGE	DOOR MFG. STANDARD	628	B/O
1	SET	PUSH/PULL BAR	9190-10"-NO	630	IVE
1	EA	OH STOP	100S	630	GLY
1	EA	SURF. AUTO OPERATOR	4642 TBWMS	689	LCN
			FLUSH CEILING MOUNT		
2	EA	ACTUATOR, WALL MOUNT	8310-853T	630	LCN
1	EA	BOLLARD POST	8310-866	AL	LCN
1	SET	PERIMETER SEAL	DOOR MFR. STD.		B/O
1	EA	DOOR SWEEP	DOOR MFR. STD.		B/O
1	EA	THRESHOLD	DOOR MFR STD.	AL	B/O

PRESSING INSIDE OR OUTSIDE ACTUATOR OPENS DOOR.

HW SET# 003 - EXTERIOR - CARD ACCESS

EACH TO HAVE:

2	EA	HW HINGE	5BB1HW 4.5 X 4.5 NRP	630	IVE
1	EA	ELECTRIC HW HINGE	5BB1HW 4.5 X 4.5 TW8	630	IVE
1	EA	ELECTRIC LOCK	RX-L9080TEU 06A	626	SCH
1	EA	FSIC CORE	23-030 EV29 T	626	SCH
1	EA	LOCK GUARD	LG1	630	IVE
1	EA	SURFACE CLOSER	4111 SCUSH TBWMS	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW	630	IVE
1	EA	DRIP CAP	16A	CL	NGP
1	SET	SEALS	127SA	CL	NGP
1	EA	DOOR SWEEP	200NA	CL	NGP
1	EA	THRESHOLD	426 MS/LA	AL	NGP
1	EA	DOOR CONTACT	679-05HM	BLK	SCE
1	EA	POWER SUPPLY	FURNISHED IN DIV 28		B/O
1	EA	CARD READER	FURNISHED IN DIV 28		B/O

OPERATION:

ENTRY BY PRESENTATION OF VALID CREDENTIAL AT READER TO RELEASE LEVER ON LOCKSET.

HW SET# 004 - EXTERIOR -CARD ACCESS (RATED)

EACH TO HAVE:

6	EA	HW HINGE	5BB1HW 4.5 X 4.5 NRP	630	IVE
2	EA	POWER TRANSFER	EPT10	689	VON
1	EA	KEYED FIRE RATED REMOVABLE MULLION	KR9954	689	VON
1	EA	ELEC FIRE EXIT HARDWARE	RX-LC-98-EO-F-499F-SNB	626	VON
1	EA	ELEC FIRE EXIT HARDWARE	RX-LC-98-L-F-E996-06-FSE-499F-SNB	626	VON
1	EA	RIM CYLINDER	20-057-ICX	626	SCH
1	EA	MORTISE CYLINDER	20-061-ICX	626	SCH
2	EA	FSIC CORE	23-030 EV29 T	626	SCH
2	EA	SURFACE CLOSER	4111 SCUSH TBWMS	689	LCN
2	EA	KICK PLATE	8400 10" X 2" LDW	630	IVE
1	EA	DRIP CAP	16A	CL	NGP
1	SET	SEALS	127SA	CL	NGP
1	EA	MULLION SEAL	5100	BLK	NGP
2	EA	DOOR SWEEP	200NA	CL	NGP
1	EA	THRESHOLD	426 MS/LA	AL	NGP
2	EA	DOOR CONTACT	679-05HM	BLK	SCE
1	EA	POWER SUPPLY	FURNISHED IN DIV 28		B/O
1	EA	CARD READER	FURNISHED IN DIV 28		B/O

OPERATION:

ENTRY BY PRESENTATION OF VALID CREDENTIAL AT READER TO RELEASE LEVER ON LOCKSET.

HW SET# 005 - EXTERIOR – COMPRESSOR-CARD ACCESS

EACH TO HAVE:

5	EA	HW HINGE	5BB1HW 4.5 X 4.5 NRP	630	IVE
1	EA	ELECTRIC HW HINGE	5BB1HW 4.5 X 4.5 TW8	630	IVE
2	EA	MANUAL FLUSH BOLT	FB458	626	IVE
1	EA	DUST PROOF STRIKE	DP1	626	IVE
1	EA	ELECTRIC LOCK	RX-L9080TEU 06A	626	SCH
1	EA	FSIC CORE	23-030 EV29 T	626	SCH
1	EA	OH STOP & HOLDER	90H	630	GLY
1	EA	SURFACE CLOSER	4111 SHCUSH TBWMS	689	LCN
2	EA	KICK PLATE	8400 10" X 2" LDW	630	IVE
1	EA	DRIP CAP	16A	CL	NGP
1	SET	SEALS	127SA	CL	NGP
1	EA	ASTRAGAL	139SP	600	NGP
			OR DOOR MFR STANDARD		
2	EA	DOOR SWEEP	200NA	CL	NGP
1	EA	THRESHOLD	426 MS/LA	AL	NGP
2	EA	DOOR CONTACT	679-05HM	BLK	SCE
1	EA	POWER SUPPLY	FURNISHED IN DIV 28		B/O
	EA	CARD READER	FURNISHED IN DIV 28		B/O

OPERATION:

ENTRY BY PRESENTATION OF VALID CREDENTIAL AT READER TO RELEASE LEVER ON LOCKSET.

HW SET# 006 - NOT USED - NOT USED

EACH TO HAVE:

HW SET# 007 - EXTERIOR - CARD ACCESS (RATED)

EACH TO HAVE:

3	EA	HW HINGE	5BB1HW 4.5 X 4.5 NRP	630	IVE
1	EA	POWER TRANSFER	EPT10	689	VON
1	EA	ELEC FIRE EXIT HARDWARE	RX-LC-98-L-F-E996-06-FSE-SNB	626	VON
1	EA	RIM CYLINDER	20-057-ICX	626	SCH
1	EA	FSIC CORE	23-030 EV29 T	626	SCH
1	EA	SURFACE CLOSER	4111 SCUSH TBWMS	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW	630	IVE
1	EA	DRIP CAP	16A	CL	NGP
1	SET	SEALS	127SA	CL	NGP
1	EA	DOOR SWEEP	200NA	CL	NGP
1	EA	THRESHOLD	426 MS/LA	AL	NGP
1	EA	DOOR CONTACT	679-05HM	BLK	SCE
1	EA	POWER SUPPLY	FURNISHED IN DIV 28		B/O
1	EA	CARD READER	FURNISHED IN DIV 28		B/O

LARGE ELECTRIC ROOM

HW SET# 101 - OFFICE W/KICKPLATE

EACH TO HAVE:

3	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	ENTRANCE LOCK	ND53TD RHO	626	SCH
1	EA	FSIC CORE	23-030 EV29 T	626	SCH
1	EA	KICK PLATE	8400 10" X 2" LDW	630	IVE
1	EA	WALL STOP	WS406CCV	630	IVE
3	EA	SILENCER	SR64	GRY	IVE

HW SET# 102 - OFFICE

EACH TO HAVE:

3	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	ENTRANCE LOCK	ND53TD RHO	626	SCH
1	EA	FSIC CORE	23-030 EV29 T	626	SCH
1	EA	WALL STOP	WS406CCV	630	IVE
3	EA	SILENCER	SR64	GRY	IVE

HW SET# 103 - CONFERENCE

EACH TO HAVE:

3	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	PASSAGE SET	ND10S RHO	626	SCH
1	EA	WALL STOP	WS406CCV	630	IVE
1	SET	SEALS	5050B	BRN	NGP

HW SET# 104 - STORAGE

EACH TO HAVE:

3	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	STOREROOM LOCK	ND80TD RHO	626	SCH
1	EA	FSIC CORE	23-030 EV29 T	626	SCH
1	EA	WALL STOP	WS406CCV	630	IVE
3	EA	SILENCER	SR64	GRY	IVE

HW SET# 105 - NOT USED

EACH TO HAVE:

HW SET# 106 - TOILET

EACH TO HAVE:

3	EA	HW HINGE	5BB1HW 4.5 X 4.5	630	IVE
1	EA	PUSH PLATE	8200 6" X 16"	630	IVE
1	EA	PULL PLATE	8303 10" 4" X 16" H	630	IVE
1	EA	SURFACE CLOSER	4011 TBWMS	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW	630	IVE
1	EA	WALL STOP	WS406CCV	630	IVE
3	EA	SILENCER	SR64	GRY	IVE

HW SET# 107 - TOILET

EACH TO HAVE:

3	EA	HW HINGE	5BB1HW 4.5 X 4.5	630	IVE
1	EA	PUSH PLATE	8200 6" X 16"	630	IVE
1	EA	PULL PLATE	8303 10" 4" X 16" F	630	IVE
1	EA	SURFACE CLOSER	4011 TBWMS	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW	630	IVE
1	EA	WALL STOP	WS406CCV	630	IVE
3	EA	SILENCER	SR64	GRY	IVE

HW SET# 108 - WASH EQUIPMENT

EACH TO HAVE:

6	EA	HW HINGE	5BB1HW 4.5 X 4.5 NRP	652	IVE
2	EA	MANUAL FLUSH BOLT	FB458	626	IVE
1	EA	DUST PROOF STRIKE	DP2	626	IVE
1	EA	STOREROOM LOCK	ND80TD RHO	626	SCH
1	EA	FSIC CORE	23-030 EV29 T	626	SCH
	EA	DOOR HOLDER	PAH60	689	LCN
1	EA	SURFACE CLOSER	4111 HEDA TBWMS	689	LCN
2	EA	KICK PLATE	8400 10" X 2" LDW	630	IVE
2	EA	WALL STOP	WS406CCV	630	IVE
1	EA	ASTRAGAL	139SP	600	NGP
2	EA	SILENCER	SR64	GRY	IVE

HW SET# 109 - PARTS

EACH TO HAVE:

3	EA	HW HINGE	5BB1HW 5 X 4.5 NRP	652	IVE
1	EA	STOREROOM LOCK	ND80TD RHO	626	SCH
1	EA	SURFACE CLOSER	4111 CUSH TBWMS	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW	630	IVE
3	EA	SILENCER	SR64	GRY	IVE

HW SET# 110 - ELEV MACHINE (RATED)

EACH TO HAVE:

3	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	STOREROOM LOCK	ND80TD RHO	626	SCH
1	EA	FSIC CORE	23-030 EV29 T	626	SCH
1	EA	SURFACE CLOSER	4011 TBWMS	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW	630	IVE
1	EA	WALL STOP	WS406CCV	630	IVE
1	SET	SEALS	5050B	BRN	NGP

HW SET# 111 - MECH/WORK MEZZ

EACH TO HAVE:

3	EA	HW HINGE	5BB1HW 4.5 X 4.5	652	IVE
1	EA	STOREROOM LOCK	ND80TD RHO	626	SCH
1	EA	FSIC CORE	23-030 EV29 T	626	SCH
1	EA	SURFACE CLOSER	4111 EDA TBWMS	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW	630	IVE
1	EA	WALL STOP	WS406CCV	630	IVE
1	SET	SEALS	127SA	CL	NGP
1	EA	DOOR SWEEP	200NA	CL	NGP
1	EA	THRESHOLD	426 MS/LA	AL	NGP

HW SET# 112 - BREAK ROOM

EACH TO HAVE:

3	EA	HW HINGE	5BB1HW 4.5 X 4.5	652	IVE
1	EA	PASSAGE SET	ND10S RHO	626	SCH
1	EA	SURFACE CLOSER	4011 H TBWMS	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW	630	IVE
1	EA	WALL STOP	WS406CCV	630	IVE
3	EA	SILENCER	SR64	GRY	IVE

HW SET# 113 - ELEVATOR /STAIR LOBBY/MEZZ

EACH TO HAVE:

3	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	PASSAGE SET	ND10S RHO	626	SCH
1	EA	SURFACE CLOSER	4111 EDA TBWMS	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW	630	IVE
1	EA	WALL STOP	WS406CCV	630	IVE
1	SET	SEALS	5050B	BRN	NGP

HW SET# 114 - JANITOR

EACH TO HAVE:

3	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	STOREROOM LOCK	ND80TD RHO	626	SCH
1	EA	FSIC CORE	23-030 EV29 T	626	SCH
1	EA	KICK PLATE	8400 10" X 2" LDW	630	IVE
1	EA	WALL STOP	WS406CCV	630	IVE
3	EA	SILENCER	SR64	GRY	IVE

HW SET# 115 - WASH BAY

EACH TO HAVE:

3	EA	HW HINGE	5BB1HW 4.5 X 4.5	630	IVE
1	EA	PASSAGE SET	ND10S RHO	626	SCH
1	EA	SURFACE CLOSER	4111 EDA TBWMS	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW	630	IVE
1	EA	WALL STOP	WS406CCV	630	IVE
1	SET	SEALS	127SA	CL	NGP
1	EA	DOOR SWEEP	200NA	CL	NGP
1	EA	THRESHOLD	426 MS/LA	AL	NGP

HW SET# 116 - LARGE ELECTRIC ROOM W/PANIC

EACH TO HAVE:

3	EA	HW HINGE	5BB1HW 4.5 X 4.5 NRP	652	IVE
1	EA	FIRE EXIT HARDWARE	98-L-NL-F-996-06-SNB	626	VON
1	EA	RIM CYLINDER	20-057-ICX	626	SCH
1	EA	FSIC CORE	23-030 EV29 T	626	SCH
1	EA	SURFACE CLOSER	4111 EDA TBWMS	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW	630	IVE
1	EA	WALL STOP	WS406CCV	630	IVE

HW SET# 117 - COPY/FILES

EACH TO HAVE:

3	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	CLASSROOM LOCK	ND70TD RHO	626	SCH
1	EA	FSIC CORE	23-030 EV29 T	626	SCH
1	EA	WALL STOP	WS406CCV	630	IVE
3	EA	SILENCER	SR64	GRY	IVE

END OF SECTION 087100

SECTION 08 80 00**GLAZING****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. This Section includes glazing for the following products and applications, including those specified in other Sections where glazing requirements are specified by reference to this Section:
 - 1. Windows.
 - 2. Doors.
 - 3. Glazed storefront.
 - 4. Glazed entrances.
 - 5. Interior borrowed lites.
 - 6. Storefront framing.

1.03 DEFINITIONS

- A. Manufacturers of Glass Products: Firms that produce primary glass, fabricated glass, or both, as defined in referenced glazing publications.
- B. Glass Thicknesses: Indicated by thickness designations in millimeters according to ASTM C 1036.
- C. Interspace: Space between lites of an insulating-glass unit that contains dehydrated air or a specified gas.
- D. Deterioration of Coated Glass: Defects developed from normal use that are attributed to the manufacturing process and not to causes other than glass breakage and practices for maintaining and cleaning coated glass contrary to manufacturer's written instructions. Defects include peeling, cracking, and other indications of deterioration in metallic coating.
- E. Deterioration of Insulating Glass: Failure of hermetic seal under normal use that is attributed to the manufacturing process and not to causes other than glass breakage and practices for maintaining and cleaning insulating glass contrary to manufacturer's written instructions. Evidence of failure is the obstruction of vision by dust, moisture, or film on interior surfaces of glass.
- F. Deterioration of Laminated Glass: Defects developed from normal use that are attributed to the manufacturing process and not to causes other than glass breakage and practices for maintaining and cleaning laminated glass contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standard.

1.04 PERFORMANCE REQUIREMENTS

- A. General: Provide glazing systems capable of withstanding normal thermal movement

and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to the following: defective manufacture, fabrication, and installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.

- B. Glass Design: Glass thickness designations indicated are minimums and are for detailing only. Confirm glass thicknesses by analyzing Project loads and in-service conditions. Provide glass lites in the thickness designations indicated for various size openings, but not less than thicknesses and in strengths (annealed or heat treated) required to meet or exceed the following criteria:
1. Glass Thicknesses: Select minimum glass thicknesses to comply with ASTM E 1300, according to the following requirements:
 - a. Specified Design Wind Loads: As indicated, but not less than wind loads applicable to Project as required by ASCE 7 "Minimum Design Loads for Buildings and Other Structures": Section 6.0 "Wind Loads."
 - b. Probability of Breakage for Vertical Glazing: 8 lites per 1000 for lites set vertically or not more than 15 degrees off vertical and under wind action.
 - 1) Load Duration: 3 seconds.
 - c. Maximum Lateral Deflection: For the following types of glass supported on all 4 edges, provide thickness required that limits center deflection at design wind pressure to 1/50 times the short side length or 1 inch, whichever is less.
 - 1) For monolithic-glass lites heat treated to resist wind loads.
 - 2) For insulating glass.
 - 3) For laminated-glass lites.
- C. Thermal Movements: Provide glazing that allows for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures acting on glass framing members and glazing components. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
1. Temperature Change (Range): 120 deg F, ambient; 180 deg F , material surfaces.
- D. Thermal and Optical Performance Properties: Provide glass with performance properties specified based on manufacturer's published test data, as determined according to procedures indicated below:
1. For monolithic-glass lites, properties are based on units with lites 6.0 mm thick.
 2. For laminated-glass lites, properties are based on products of construction indicated.
 3. For insulating-glass units, properties are based on units of thickness indicated for overall unit and for each lite.
 4. Center-of-Glass Values: Based on using LBL-44789 WINDOW 5.0 computer program for the following methodologies:
 - a. U-Factors: NFRC 100 expressed as Btu/ sq. ft. x h x deg F .
 - b. Solar Heat Gain Coefficient: NFRC 200.
 - c. Solar Optical Properties: NFRC 300.

1.05 SUBMITTALS

- A. Product Data: For each glass product and glazing material indicated.
- B. Samples: For the following products, in the form of 12-inch- square Samples for glass and of 12-inch-long Samples for sealants. Install sealant Samples between two strips of material representative in color of the adjoining framing system.
- C. Samples: For the following products, in the form of 12-inch- square Samples for glass.
 - 1. Each color of tinted float glass.
 - 2. Coated vision glass.
 - 3. Ceramic-coated spandrel glass.
 - 4. Wired glass.
 - 5. Fire-resistive glazing products.
 - 6. Insulating glass for each designation indicated.
 - 7. For each color (except black) of exposed glazing sealant indicated.
- D. Glazing Schedule: Use same designations indicated on Drawings for glazed openings in preparing a schedule listing glass types and thicknesses for each size opening and location.
- E. Product Certificates: Signed by manufacturers of glass and glazing products certifying that products furnished comply with requirements.
 - 1. For solar-control low-e-coated glass, provide documentation demonstrating that manufacturer of coated glass is certified by coating manufacturer.
- F. Qualification Data: For installers.
- G. Preconstruction Adhesion and Compatibility Test Report: From glazing sealant manufacturer indicating glazing sealants were tested for adhesion to glass and glazing channel substrates and for compatibility with glass and other glazing materials.
- H. Product Test Reports: For each of the following types of glazing products:
 - 1. Tinted float glass.
 - 2. Coated float glass.
 - 3. Insulating glass.
 - 4. Glazing sealants.
 - 5. Glazing gaskets.
- I. Warranties: Special warranties specified in this Section.

1.06 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who has completed glazing similar in material, design, and extent to that indicated for this Project; whose work has resulted in glass installations with a record of successful in-service performance; and who employs glass installers for this Project who are certified under the National Glass Association's Certified Glass Installer Program.
- B. Source Limitations for Glass: Obtain the following through one source from a single manufacturer for each glass type: clear float glass coated float glass and insulating glass.
- C. Source Limitations for Glass Sputter-Coated with Solar-Control Low-E Coatings:

Where solar-control low-e coatings of a primary glass manufacturer that has established a certified fabricator program is specified, obtain sputter-coated solar-control low-e-coated glass in fabricated units from a manufacturer that is certified by coated-glass manufacturer.

- D. Source Limitations for Glazing Accessories: Obtain glazing accessories through one source from a single manufacturer for each product and installation method indicated.
- E. Glass Product Testing: Obtain glass test results for product test reports in "Submittals" Article from a qualified testing agency based on testing glass products.
 - 1. Glass Testing Agency Qualifications: An independent testing agency with the experience and capability to conduct the testing indicated, as documented according to ASTM E 548.
 - 2. Glass Testing Agency Qualifications: An independent testing agency accredited according to the NFRC CAP 1 Certification Agency Program.
- F. Elastomeric Glazing Sealant Product Testing: Obtain sealant test results for product test reports in "Submittals" Article from a qualified testing agency based on testing current sealant formulations within a 36-month period.
 - 1. Sealant Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated, as documented according to ASTM E 548.
 - 2. Test elastomeric glazing sealants for compliance with requirements specified by reference to ASTM C 920, and where applicable, to other standard test methods.
- G. Glazing for Fire-Rated Door Assemblies: Glazing for assemblies that comply with NFPA 80 and that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing according to NFPA 252.
- H. Glazing for Fire-Rated Window Assemblies: Glazing for assemblies that comply with NFPA 80 and that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to NFPA 257.
- I. Safety Glazing Products: Comply with testing requirements in 16 CFR 1201 and, for wired glass, ANSI Z97.1.
 - 1. Where glazing units, including Kind FT glass and laminated glass, are specified in Part 2 articles for glazing lites more than 9 sq. ft. in exposed surface area of one side, provide glazing products that comply with Category II materials, for lites 9 sq. ft. or less in exposed surface area of one side, provide glazing products that comply with Category I or II materials, except for hazardous locations where Category II materials are required by 16 CFR 1201 and regulations of authorities having jurisdiction.
- J. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below, unless more stringent requirements are indicated. Refer to these publications for glazing terms not otherwise defined in this Section or in referenced standards.
 - 1. GANA Publications: GANA Laminated Division's "Laminated Glass Design Guide" and GANA's "Glazing Manual."
 - 2. IGMA Publication for Insulating Glass: SIGMA TM-3000, "Glazing Guidelines for Sealed Insulating Glass Units."

- K. Insulating-Glass Certification Program: Permanently marked either on spacers or on at least one component lite of units with appropriate certification label of the following testing and inspecting agency:
 - 1. Insulating Glass Certification Council.
 - 2. Associated Laboratories, Inc.
- L. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
 - 1. Build mockups in the location and of the size indicated or, if not indicated, as directed by Architect.
 - 2. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
- M. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Protect glazing materials according to manufacturer's written instructions and as needed to prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.
- B. For insulating-glass units that will be exposed to substantial altitude changes, comply with insulating-glass manufacturer's written recommendations for venting and sealing to avoid hermetic seal ruptures.

1.08 PROJECT CONDITIONS

- A. Environmental Limitations: Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by glazing material manufacturers and when glazing channel substrates are wet from rain, frost, condensation, or other causes.
 - 1. Do not install liquid glazing sealants when ambient and substrate temperature conditions are outside limits permitted by glazing sealant manufacturer or below 40 deg F .

1.09 WARRANTY

- A. Manufacturer's Special Warranty for Coated-Glass Products: Manufacturer's standard form, made out to Owner and signed by coated-glass manufacturer agreeing to replace coated-glass units that deteriorate as defined in "Definitions" Article, f.o.b. the nearest shipping point to Project site, within specified warranty period indicated below.
 - 1. Warranty Period: 10 years from date of Substantial Completion.
- B. Manufacturer's Special Warranty on Insulating Glass: Manufacturer's standard form, made out to Owner and signed by insulating-glass manufacturer agreeing to replace insulating-glass units that deteriorate as defined in "Definitions" Article, f.o.b. the nearest shipping point to Project site, within specified warranty period indicated below.
 - 1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products specified.
 2. Products: Subject to compliance with requirements, provide one of the products specified.
 3. Product: Subject to compliance with requirements, provide product specified.
 4. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
 5. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
 6. Basis-of-Design Product: The design for each glazing product is based on the product named. Subject to compliance with requirements, provide either the named product or a comparable product by one of the other manufacturers specified.

2.02 GLASS PRODUCTS

- A. Annealed Float Glass: ASTM C 1036, Type I (transparent flat glass), Quality-Q3; of class indicated.
- B. Heat-Treated Float Glass: ASTM C 1048; Type I (transparent flat glass); Quality-Q3; of class, kind, and condition indicated.
1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed, unless otherwise indicated.
 2. Provide Kind HS (heat-strengthened) float glass in place of annealed float glass where needed to resist thermal stresses induced by differential shading of individual glass lites and to comply with glass design requirements specified in Part 1 "Performance Requirements" Article.
 3. For uncoated glass, comply with requirements for Condition A.
 4. For coated vision glass, comply with requirements for Condition C (other uncoated glass).
 5. Provide Kind FT (fully tempered) float glass in place of annealed or Kind HS (heat-strengthened) float glass where safety glass is indicated.
- C. Sputter-Coated Float Glass: ASTM C 1376, float glass with metallic-oxide or -nitride coating deposited by vacuum deposition process after manufacture and heat treatment (if any), and complying with other requirements specified.
- D. Insulating-Glass Units, General: Factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace, and complying with ASTM E 774 for Class CBA units and with requirements specified in this Article and in Part 2 "Insulating-Glass Units" Article.
1. Provide Kind HS (heat-strengthened) float glass in place of annealed glass where needed to resist thermal stresses induced by differential shading of individual glass lites and to comply with glass design requirements specified in Part 1 "Performance Requirements" Article.
 2. Overall Unit Thickness and Thickness of Each Lite: Dimensions indicated for insulating-glass units are nominal and the overall thicknesses of units are

- measured perpendicularly from outer surfaces of glass lites at unit's edge.
3. Sealing System: Dual seal, with primary and secondary sealants as follows:
 - a. Manufacturer's standard sealants.
 4. Spacer Specifications: Manufacturer's standard spacer material and construction.

2.03 FIRE-PROTECTION-RATED GLAZING

- A. Fire-Protection-Rated Glazing, General: Listed and labeled by a testing agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing according to NFPA 252 for door assemblies and NFPA 257 for window assemblies.
- B. Fire-Protection-Rated Laminated Glass: 5/16-inch-thick, fire-protection-rated laminated glass, complying with testing requirements in 16 CFR 1201 for Category II materials.
 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Oldcastle Glass, Inc.; Pyroguard.

2.04 GLAZING GASKETS

- A. Dense Compression Gaskets: Molded or extruded gaskets of material indicated below, complying with standards referenced with name of elastomer indicated below, and of profile and hardness required to maintain watertight seal:
 1. Neoprene, ASTM C 864.
 2. EPDM, ASTM C 864.
 3. Silicone, ASTM C 1115.
 4. Thermoplastic polyolefin rubber, ASTM C 1115.
 5. Any material indicated above.
- B. Soft Compression Gaskets: Extruded or molded, closed-cell, integral-skinned gaskets of material indicated below; complying with ASTM C 509, Type II, black; and of profile and hardness required to maintain watertight seal:
 1. Neoprene.
 2. EPDM.
 3. Silicone.
 4. Thermoplastic polyolefin rubber.
 5. Any material indicated above.
- C. Lock-Strip Gaskets: Neoprene extrusions in size and shape indicated, fabricated into frames with molded corner units and zipper lock-strips, complying with ASTM C 542, black.

2.05 GLAZING SEALANTS

- A. General: Provide products of type indicated, complying with the following requirements:
 1. Compatibility: Select glazing sealants that are compatible with one another and with other materials they will contact, including glass products, seals of insulating-glass units, and glazing channel substrates, under conditions of

- service and application, as demonstrated by sealant manufacturer based on testing and field experience.
2. Suitability: Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.
 3. Colors of Exposed Glazing Sealants: As selected by Architect from manufacturer's full range.
- B. Glazing Sealants for Fire-Resistive Glazing Products: Identical to products used in test assemblies to obtain fire-protection rating.

2.06 GLAZING TAPES

- A. Back-Bedding Mastic Glazing Tapes: Preformed, butyl-based elastomeric tape with a solids content of 100 percent; nonstaining and nonmigrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and glass manufacturers for application indicated; packaged on rolls with a release paper backing; and complying with ASTM C 1281 and AAMA 800 for products indicated below:
1. AAMA 804.3 tape, where indicated.
 2. AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.
 3. AAMA 807.3 tape, for glazing applications in which tape is not subject to continuous pressure.
- B. Expanded Cellular Glazing Tapes: Closed-cell, PVC foam tapes; factory coated with adhesive on both surfaces; packaged on rolls with release liner protecting adhesive; and complying with AAMA 800 for the following types:
1. Type 1, for glazing applications in which tape acts as the primary sealant.
 2. Type 2, for glazing applications in which tape is used in combination with a full bead of liquid sealant.

2.07 MISCELLANEOUS GLAZING MATERIALS

- A. General: Provide products of material, size, and shape complying with referenced glazing standard, requirements of manufacturers of glass and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.
- B. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.
- C. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.
- D. Spacers: Elastomeric blocks or continuous extrusions with a Shore, Type A durometer hardness required by glass manufacturer to maintain glass lites in place for installation indicated.
- E. Edge Blocks: Elastomeric material of hardness needed to limit glass lateral movement (side walking).
- F. Cylindrical Glazing Sealant Backing: ASTM C 1330, Type O (open-cell material), of size and density to control glazing sealant depth and otherwise produce optimum glazing sealant performance.

- G. Perimeter Insulation for Fire-Resistive Glazing: Identical to product used in test assembly to obtain fire-resistance rating.

2.08 FABRICATION OF GLAZING UNITS

- A. Fabricate glazing units in sizes required to glaze openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing publications, to comply with system performance requirements.
- B. Clean-cut or flat-grind vertical edges of butt-glazed monolithic lites in a manner that produces square edges with slight kerfs at junctions with outdoor and indoor faces.
- C. Grind smooth and polish exposed glass edges and corners.

2.09 MONOLITHIC FLOAT-GLASS UNITS

- A. Uncoated Clear Float-Glass Units - GL-02: Class 1 (clear).
1. Thickness: 6.0 mm.
- B. Uncoated Clear Float-Glass Units - GL-02T: Class 1 (clear) Kind FT (fully tempered) float glass.
1. Thickness: 6.0 mm.

2.10 INSULATING-GLASS UNITS

- A. South Elevation: Low-e-coated on no. 3 surface, clear insulating glass unit, heat-treated, 1 inch thickness (double pane), air filled with stainless steel spacer:
1. Performance:
 - a. Visible Light Transmittance: 70% minimum.
 - b. Visible Light Reflectance - Exterior: 11% approximate.
 - c. U-Value Winter: 0.29 minimum.
 - d. U-Value Summer: 0.26 minimum.
 - e. Shading Coefficient: 0.44 approximate.
 - f. Solar Heat Gain Coef.: 0.38 approximate.
 - g. Light to Solar Gain Ratio: 1.84 approximate.
 - h. Available Product: Viracon VE 1-85.
- B. North Elevation: Low-e-coated on no. 4 surface, clear insulating glass unit, heat-treated, 1 inch thickness (double pane), air filled with stainless steel spacer, fully tempered:
1. Performance:
 - a. Visible Light Transmittance: 48% minimum.
 - b. Visible Light Reflectance - Exterior: 11% approximate.
 - c. U-Value Winter: 0.20 minimum.
 - d. U-Value Summer: 0.17 minimum.
 - e. Shading Coefficient: 0.29 approximate.
 - f. Solar Heat Gain Coef.: 0.25 approximate.
 - g. Light to Solar Gain Ratio: 1.92 approximate.
 - h. Available Product: Viracon VUE 1-50.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine framing glazing, with Installer present, for compliance with the following:
 - 1. Manufacturing and installation tolerances, including those for size, squareness, and offsets at corners.
 - 2. Presence and functioning of weep system.
 - 3. Minimum required face or edge clearances.
 - 4. Effective sealing between joints of glass-framing members.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings not firmly bonded to substrates.

3.03 GLAZING, GENERAL

- A. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.
- B. Glazing channel dimensions, as indicated on Drawings, provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances. Adjust as required by Project conditions during installation.
- C. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass is glass with edge damage or other imperfections that, when installed, could weaken glass and impair performance and appearance.
- D. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction sealant-substrate testing.
- E. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.
- F. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.
- G. Provide spacers for glass lites where length plus width is larger than 50 inches as follows:
 - 1. Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face clearances, unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with system performance requirements.
 - 2. Provide 1/8-inch minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.

- H. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and according to requirements in referenced glazing publications.
- I. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.
- J. Where wedge-shaped gaskets are driven into one side of channel to pressurize sealant or gasket on opposite side, provide adequate anchorage so gasket cannot walk out when installation is subjected to movement.
- K. Square cut wedge-shaped gaskets at corners and install gaskets in a manner recommended by gasket manufacturer to prevent corners from pulling away; seal corner joints and butt joints with sealant recommended by gasket manufacturer.

3.04 TAPE GLAZING

- A. Position tapes on fixed stops so that, when compressed by glass, their exposed edges are flush with or protrude slightly above sightline of stops.
- B. Install tapes continuously, but not necessarily in one continuous length. Do not stretch tapes to make them fit opening.
- C. Cover vertical framing joints by applying tapes to heads and sills first and then to jambs. Cover horizontal framing joints by applying tapes to jambs and then to heads and sills.
- D. Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant approved by tape manufacturer.
- E. Do not remove release paper from tape until just before each glazing unit is installed.
- F. Apply heel bead of elastomeric sealant.
- G. Center glass lites in openings on setting blocks and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.
- H. Apply cap bead of elastomeric sealant over exposed edge of tape.

3.05 GASKET GLAZING (DRY)

- A. Fabricate compression gaskets in lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.
- B. Insert soft compression gasket between glass and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.
- C. Center glass lites in openings on setting blocks and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.
- D. Install gaskets so they protrude past face of glazing stops.

3.06 SEALANT GLAZING (WET)

- A. Install continuous spacers, or spacers combined with cylindrical sealant backing, between glass lites and glazing stops to maintain glass face clearances and to prevent sealant from extruding into glass channel and blocking weep systems until sealants cure. Secure spacers or spacers and backings in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.
- B. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to glass and channel surfaces.
- C. Tool exposed surfaces of sealants to provide a substantial wash away from glass.

3.07 LOCK-STRIP GASKET GLAZING

- A. Comply with ASTM C 716 and gasket manufacturer's written instructions. Provide supplementary wet seal and weep system, unless otherwise indicated.

3.08 CLEANING AND PROTECTION

- A. Protect exterior glass from damage immediately after installation by attaching crossed streamers to framing held away from glass. Do not apply markers to glass surface. Remove nonpermanent labels, and clean surfaces.
- B. Protect glass from contact with contaminating substances resulting from construction operations, including weld splatter. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended by glass manufacturer.
- C. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains; remove as recommended in writing by glass manufacturer.
- D. Remove and replace glass that is broken, chipped, cracked, or abraded or that is damaged from natural causes, accidents, and vandalism, during construction period.
- E. Wash glass on both exposed surfaces in each area of Project not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash glass as recommended in writing by glass manufacturer.

END OF SECTION 08 80 00

1.4 SUBMITTALS**A. Shop Drawings:**

1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
2. Product technical data including:
 - a. Acknowledgement that products submitted meet requirements of standards referenced.
 - b. Manufacturer's installation instructions.
 - c. Certification that glass has been tested and approved for use in fire rated doors or walls.
 - 1) Copies of all test criteria.
3. Certification that insulated glass units meet requirements of IGCC and are certified by IGCC to ASTM E2190.

B. Samples:

1. 12 x 12 IN sample of each type, color, and thickness specified except clear glass (glass Type 1 and 2.)

PART 2 - PRODUCTS**2.1 ACCEPTABLE MANUFACTURERS****A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:**

1. Clear glass - tempered, float and heat strengthened:
 - a. Libbey-Owens-Ford.
 - b. PPG.
 - c. Viracon.
 - d. Visteon.
2. Gaskets, glazing compounds, setting blocks, spacers, sealant, sealant tape, etc., as recommended by glass manufacturer, glass unit fabricator, or as required by NFPA.

B. Submit request for substitution in accordance with Specification Section 01 25 00.**2.2 MATERIALS****A. Shelter Structure: Clear Tempered, Laminated Float Glass:**

1. (2) 1/4 IN thick outer layers with a vinyl inner layer for 9/16 IN overall thickness.
2. ASTM C1048.
 - a. Kind FT, Kind FT, Condition A, Type 1, Class I.
3. ANSI Z97.1.
4. Inner Layer: Polyvinyl butyral (PVB) plastic interlayer, clear. .090 IN thick.

B. Frameless Guardrail: Clear Tempered, Laminated, Float Frit Glass.

1. 1) 1/4 IN fritted 80% opaque round white grid coated to inside face of outer layer, and (1) 1/4 IN thick clear inside layer with an middle layer of vinyl for 9/16 IN overall thickness.
2. Glazing Manufacturer Standard to comply with Clear Tempered, Laminated Float Glass.
3. ASTM C1048, Kind FT, Condition A, Type 1, Class I.
4. ANSI Z97.1.
5. Inner Layer: Polyvinyl butyl (PVB) plastic interlayer, clear .090 IN thick

- 1
- 2 C. Glazing Compounds:
- 3 1. Non-sag, non-stain type.
- 4 2. Pigmented to match frame units not requiring painting.
- 5 3. Compatible with adjacent surfaces.
- 6 4. One- or two-part polyurethane or silicone sealant for use in setting glass.
- 7 a. Provide glazing compounds which will not be affected by chemicals stored in
- 8 rooms where glazing compounds are used.
- 9 D. Sealant Tape: Butyl rubber sealant tape or ribbon having a continuous neoprene shim.
- 10 E. Gaskets:
- 11 1. Flexible polyvinyl chloride or neoprene.
- 12 a. Provide gaskets which will not be affected by chemicals stored in rooms where
- 13 gaskets are used.
- 14 2. Extruded of profile and hardness required to receive glass and provide a watertight
- 15 installation.
- 16 3. Provide gaskets in accordance with NFPA in fire rated glazing.
- 17 F. Setting Blocks and Spacers:
- 18 1. Neoprene or EPDM, compatible with sealants used.
- 19 2. Setting blocks: 70-90 durometer.
- 20 3. Spacers: 40-50 durometer.
- 21 G. Compressible Filler Stock: Closed-cell jacketed rod stock of synthetic rubber or plastic
- 22 foam.
- 23 H. Shims, Clips, Springs, Angles, Beads, Attachment Screws and Other Miscellaneous
- 24 Items: As required by condition.

25 PART 3 - EXECUTION

26 3.1 INSTALLATION

- 27 A. Provide safety glazing in all locations where required by the Building Code and CPSC
- 28 16 CFR 1201.
- 29 B. Install in accordance with recommendations of manufacturer, GANA Glazing Manual
- 30 and IGMA TM-3000.
- 31 C. Install setting blocks in adhesive or sealant.
- 32 D. Install spacers inside and out, of proper size and spacing, for all glass sizes larger than
- 33 50 united inches, except where gaskets are used for glazing.
- 34 E. Provide 1/8 IN minimum bite of spacers on glass.
- 35 F. Spacer thickness to equal sealant width.
- 36 G. Prevent sealant exudation from glazing channels of insulating glass which is more than
- 37 1/2 IN thick; colored, heat absorbing, coated or laminated glass sizes larger than 75
- 38 united inches; and other glass more than 9/32 IN thick or larger than 125 united inches.
- 39 1. Leave void at heel (or install filler) at jambs and head.
- 40 2. Do not leave void (or install filler) at sill.
- 41 H. Miter cut and bond gasket ends together at corners.
- 42 I. Immediately after installation, attach crossed streamers to framing held away from
- 43 glass.

- 1 J. Use polysulfide-based glazing sealants in window assembly and as perimeter sealant
2 around frames in areas which may be exposed to chlorine gas or chlorine liquid splash
3 or spillage.
4 1. See Specification Section 07 92 13 for sealants.

5 **3.2 FIELD QUALITY CONTROL**

- 6 A. Do not install glass with edge damage.
7 B. Do not apply anything to surfaces of glass.
8 C. Remove and replace damaged glass.

9 **3.3 CLEANING**

- 10 A. Maintain glass reasonably clean during construction, so that it will not be damaged by
11 corrosive action and will not contribute to deterioration of other materials.
12 B. Wash and polish glass on both faces not more than seven (7) days prior to acceptance
13 of work in each area.
14 1. Comply with glass manufacturer's recommendations.
-

16

17 **PART 4 - MEASUREMENT**

18

- 19 **4.1 Measurement** – No Separate measurement will be made for Work described in this
20 Section.

21

22

23 **PART 5 - PAYMENT**

24

- 25 **5.1 Payment** – Payment for items in this Section will be incidental to the Contract lump sum
26 cost of the Station Stops.

27

END OF SECTION

SECTION 08 83 00**MIRRORS****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section includes the following types of silvered flat glass mirrors:

- 1. Annealed monolithic glass mirrors.

1.03 SUBMITTALS

- A. Product Data: For each type of product indicated.
 - 1. Mirrors. Include description of materials and process used to produce each type of silvered flat glass mirror specified that indicates sources of glass, glass coating components, edge sealer, and quality-control provisions.
- B. LEED Submittals:
 - 1. Product Data for Credit IEQ 4.1: For adhesives, documentation including printed statement of VOC content.
- C. Shop Drawings: Include mirror elevations, edge details, mirror hardware, and attachments to other work.
- D. Samples: For each type of the following products:
 - 1. Mirrors: 12 inches square, including edge treatment on two adjoining edges.
 - 2. Mirror Clips: Full size.
 - 3. Mirror Trim: 12 inches long.
- E. Qualification Data: For qualified Installer.
- F. Product Certificates: For each type of mirror and mirror mastic, from manufacturer.
- G. Preconstruction Test Reports: From mirror manufacturer indicating that mirror mastic was tested for compatibility and adhesion with mirror backing paint and substrates on which mirrors are installed.
- H. Warranty: Sample of special warranty.
- I. Maintenance Data: For mirrors to include in maintenance manuals.

1.04 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified installer who employs glass installers for this Project who are certified under the National Glass Association's Certified Glass Installer Program.

- B. Source Limitations for Mirrors: Obtain mirrors from single source from single manufacturer.
- C. Source Limitations for Mirror Accessories: Obtain mirror glazing accessories from single source.
- D. Glazing Publications: Comply with the following published recommendations:
 - 1. GANA's "Glazing Manual" unless more stringent requirements are indicated. Refer to this publication for definitions of glass and glazing terms not otherwise defined in this Section or in referenced standards.
 - 2. GANA Mirror Division's "Mirrors, Handle with Extreme Care: Tips for the Professional on the Care and Handling of Mirrors."
- E. Preconstruction Mirror Mastic Compatibility Test: Submit mirror mastic products to mirror manufacturer for testing to determine compatibility of mastic with mirror backing paint and substrates on which mirrors are installed.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Protect mirrors according to mirror manufacturer's written instructions and as needed to prevent damage to mirrors from moisture, condensation, temperature changes, direct exposure to sun, or other causes.
- B. Comply with mirror manufacturer's written instructions for shipping, storing, and handling mirrors as needed to prevent deterioration of silvering, damage to edges, and abrasion of glass surfaces and applied coatings. Store indoors.

1.06 PROJECT CONDITIONS

- A. Environmental Limitations: Do not install mirrors until ambient temperature and humidity conditions are maintained at levels indicated for final occupancy.

1.07 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which mirror manufacturer agrees to replace mirrors that deteriorate within specified warranty period. Deterioration of mirrors is defined as defects developed from normal use that are not attributed to mirror breakage or to maintaining and cleaning mirrors contrary to manufacturer's written instructions. Defects include discoloration, black spots, and clouding of the silver film.
 - 1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 SILVERED FLAT GLASS MIRRORS

- A. Glass Mirrors, General: ASTM C 1503.

2.02 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. American Mirror Co.

- a. Consolidated Glass & Mirror Corp.
2. Falconer Glass Industries, Inc.
3. Gardner Mirror Corp.

2.03 FLOAT GLASS

- A. Tempered Float Glass: ASTM C 1048, Type I (transparent glass, flat), Condition A (uncoated), Kind FT (fully tempered), Quality q3 (glazing select) float glass, complying with the following requirements:
 1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of mirror as installed, unless otherwise indicated.
 2. Clear Tempered Float Glass: Class 1 (clear).
 - a. Thickness: 6 mm.

2.04 MIRRORING GLASS

- A. Silvered Mirrored Glass: Annealed and tempered, clear float glass with successive layers of chemically deposited silver, electrically or chemically deposited copper, and manufacturer's standard organic protective coating applied to second glass surface to produce a coating system complying with FS DD-M-411.

2.05 FABRICATION

- A. Mirrored Glass Sizes: Cut mirrored glass to final sizes and shapes as indicated on Drawings.
- B. Cutouts: Fabricate cutouts for notches and holes in mirrored glass without marring visible surfaces. Locate and size cutouts so they fit closely around penetrations in mirrored glass.
- A. Mirrored Glass Edge Treatment: Treat edges as indicated below.
 1. Mirrors in restrooms: Flat polished edge.
 2. Seal edges of silvered mirrored glass after edge treatment to prevent chemical or atmospheric penetration of glass coating.
 3. Require mirrored glass manufacturer to perform edge treatment and sealing in factory immediately after cutting to final sizes.

2.06 MISCELLANEOUS MATERIALS

- A. Edge Sealer: Coating compatible with glass coating and approved by mirrored glass manufacturer for use in protecting against silver deterioration at mirrored glass edges.

2.07 MASTIC MATERIALS

- A. Mirror Mastic: An adhesive setting compound, produced specifically for setting mirrored glass by spot application, certified by both mirrored glass manufacturer and mastic manufacturer as compatible with glass coating and substrates on which mirrored glass will be installed.
 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

- a. Gunther Mirror Mastics.
- b. Palmer Products Corporation.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates, over which mirrored glass units are to be mounted, with Installer present, for compliance with installation tolerances, substrate preparation, and other conditions affecting performance.
 1. Verify compatibility with and suitability of substrates, including compatibility of mirror mastic with existing finishes or primers.
 2. Proceed with mirrored glass installation only after unsatisfactory conditions have been corrected and surfaces are dry.

1.02 PREPARATION

- B. Comply with mastic manufacturer's written installation instructions for preparation of substrates, including coating surfaces with mastic manufacturer's special bond coating where applicable.

3.02 GLAZING

- A. General: Install mirrored glass units to comply with written instructions of mirrored glass manufacturer and with referenced GANA and NAAMM publications. Mount mirrored glass accurately in place in a manner that avoids distorting reflected images.
- B. Provide space for air circulation between back of mirrored glass units and face of mounting surface.
- C. Frame Mounting Installation System: For wall-mounted mirrored glass units, install permanent means of support at bottom and top edges with bottom support designed to withstand mirrored glass weight and top support designed to prevent mirrored glass from coming away from wall along top edges.
 1. Attach mirror hardware securely to mounting surfaces with mechanical fasteners installed with anchors or inserts as applicable. Install fasteners so heads do not impose point loads on backs of mirrored glass units.
 2. For continuous bottom supports, provide setting blocks 1/8 inch thick by 4 inches long at quarter points.
 3. Install aluminum bottom and top trim. Fabricate trim in single lengths to fit and cover top and bottom edges of mirrored glass units.

3.03 PROTECTION AND CLEANING

- A. Protect mirrored glass from breakage and contaminating substances resulting from construction operations.
 1. Do not permit edges of silvered mirrored glass to be exposed to standing water.
 2. Maintain environmental conditions that will prevent silvered mirrored glass from being exposed to moisture from condensation or other sources for continuous periods of time.
- B. Wash mirrored glass not more than four days before date scheduled for inspections intended to establish date for Substantial Completion. Wash mirrored glass by

methods recommended in NAAMM publication and in writing by mirrored glass manufacturer. Use water and glass cleaners free from substances capable of damaging mirrored glass edges or coatings.

END OF SECTION 08 83 00

1.5 WARRANTY

- A. Written five (5) year warranty signed by installer to cover weathertightness of installation including water integrity.
- B. Written five (5) year warranty signed by manufacturer or fabricator against discoloration and breakage.

PART 2 - PRODUCTS**2.1 ACCEPTABLE MANUFACTURERS**

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Plastic glazing:
 - a. Lucite
 - b. Reynolds Polymer
 - c. Arkema Inc.

2.2 MATERIALS

- A. General:
 1. Cast acrylic glazing sheet.
 2. UV stabilized.
 3. Light transmission:
 - a. Roof Canopy: 20 percent (colorless sheet with translucent vinyl coating on surface 1).
 - b. Light Fixture Cover: 80 Percent (colorless sheet with smooth, translucent finish)
 - c. Stop Marker: 92% min (colorless)
 4. Flame spread: ASTM E84, maximum 80.
 5. Extend of burning: ASTM D635, classification CC1.
 6. Smoke density: ASTM D2843, not greater than 75.
 7. Self ignition: Minimum temperature of 650 DegF per ASTM D1929
 8. Surface Abrasion Resistance: 1000 cycles <2% ASTM D1044
 9. Yellowness Index (YI): Less than 0.3
- B. Plastic Glazing (Single Sheet):
 1. Minimum thickness: As indicated in the Drawings
 2. Color: Clear
- C. Glazing Compounds:
 1. Nonsag, nonstain type.
 2. Pigmented to match frame units not requiring painting.
 3. Compatible with adjacent surfaces.
 4. One or two-part silicone sealant for use in setting polycarbonate glazing.
 5. Approved by glazing manufacturer.
- D. Sealant Tape: Butyl rubber sealant tape or ribbon having a continuous neoprene shim approved by glazing manufacturer.
- E. Gaskets:
 1. Flexible neoprene or EPDM.
 2. Extruded of profile and hardness required to receive glazing and provide a watertight installation.
 3. Approved by glazing manufacturer.
- F. Setting Blocks and Spacers:
 1. Neoprene, compatible with sealants used.

- 1 2. Setting blocks: 70-90 durometer.
- 2 3. Spacers: 40-50 durometer.
- 3 4. Approved by glazing manufacturer.
- 4 G. Compressible Filler Stock: Closed-cell jacketed rod stock of synthetic rubber approved
- 5 by glazing manufacturer.
- 6 H. Shims, Clips, Springs, Angles, Beads, Attachment Screws and Other Miscellaneous
- 7 Items: As indicated on Drawings or required.

8 **PART 3 - EXECUTION**

9 **3.1 INSTALLATION**

- 10 A. Install products in accordance with manufacturer's instructions.
- 11 B. Install setting blocks when required in adhesive or sealant.
- 12 C. Install spacers when required inside and out, of proper size and spacing, for all glazing
- 13 sizes larger than 50 united inches, except where gaskets are used for glazing.
- 14 D. Provide minimum bite of spacers on glazing per glazing manufacturer.
- 15 E. Spacer thickness to equal sealant width.
- 16 F. Prevent sealant exudation from glazing channels of thermal unit which is more than 1/2
- 17 IN thick; colored, coated or laminated glazing sizes larger than 75 united inches; and
- 18 other glazing more than 9/32 IN thick or larger than 125 united inches.
- 19 1. Leave void at heel (or install filler) at jambs and head.
- 20 2. Do not leave void (or install filler) at sill.
- 21 G. Miter cut and bond gasket ends together at corners.
- 22 H. Immediately after installation, attach crossed streamers to framing held away from
- 23 glazing.
- 24 I. Factory cut glazing to sizes required.
- 25 1. Field cutting of glazing panels is not allowed.

26 **3.2 FIELD QUALITY CONTROL**

- 27 A. Do not install glazing with edge damage.
- 28 B. Do not apply anything to surfaces of glazing.
- 29 C. Remove, and replace damaged glazing.

30 **3.3 CLEANING AND PROTECTION**

- 31 A. Protect glazing from scratch damage and UV exposure prior to acceptance of building
- 32 by Owner.
- 33 B. Maintain glazing reasonably clean during construction, so that surfaces will not be
- 34 damaged by corrosive action and will not contribute to deterioration of other materials.
- 35 C. Wash both faces not more than seven (7) days prior to acceptance of work in each
- 36 area.
- 37 1. Comply with manufacturer's recommendations.

38 **PART 4 - MEASUREMENT**

- 39
- 40 **4.1 Measurement** – No Separate measurement will be made for Work described in this
- 41 Section.
- 42
- 43

1 **PART 5 - PAYMENT**

2

3 **5.1 Payment** – Payment for items in this Section will be incidental to the Contract lump sum
4 cost of the Station Stops.

5

6

7

8

END OF SECTION

9

SECTION 09 22 16**NON-STRUCTURAL METAL FRAMING****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY**A. Section Includes:**

- 1. Non-load-bearing steel framing systems for interior gypsum board assemblies.
- 2. Suspension systems for interior gypsum ceilings, soffits, and grid systems.

B. Related Requirements:

- 1. Section 05 40 00 "Cold-Formed Metal Framing" for exterior and interior load-bearing and exterior non-load-bearing wall studs; floor joists; roof rafters and ceiling joists; and roof trusses.

1.03 SUBMITTALS**A. Product Data:** For each type of product.**B. LEED Submittals:**

- 1. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating costs for each product having recycled content.

C. Evaluation Reports: For dimpled steel studs and runners and firestop tracks, from ICC-ES.**PART 2 - PRODUCTS****2.01 DESCRIPTION**

- A. Fire-Test-Response Characteristics: For fire-resistance-rated assemblies that incorporate non-load-bearing steel framing, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing agency.
- B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.
- C. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

2.02 FRAMING SYSTEMS

-
- A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
- B. Framing Members, General: Comply with ASTM C 754 for conditions indicated.
1. Steel Sheet Components: Comply with ASTM C 645 requirements for metal unless otherwise indicated.
 2. Protective Coating: Coating with equivalent corrosion resistance of ASTM A 653/A 653M, G40, hot-dip galvanized, unless otherwise indicated.
- C. Studs and Runners: ASTM C 645. Use either steel studs and runners or dimpled steel studs and runners.
1. Steel Studs and Runners:
 - a. Minimum Base-Metal Thickness: 0.027 inch.
 - b. Depth: As indicated on Drawings.
 2. Dimpled Steel Studs and Runners:
 - a. Minimum Base-Metal Thickness: 0.025 inch.
 - b. Depth: As indicated on Drawings.
- D. Slip-Type Head Joints: Where indicated, provide one of the following:
1. Deflection Track: Steel sheet top runner manufactured to prevent cracking of finishes applied to interior partition framing resulting from deflection of structure above; in thickness not less than indicated for studs and in width to accommodate depth of studs.
 - a. Products: Subject to compliance with requirements, provide one of the following:
 - 1) ClarkDietrich Metal Framing; SLP-TRK Slotted Deflection Track.
 - 2) MBA Building Supplies; Slotted Deflecto Track.
 - 3) Steel Network Inc. (The); VertiTrack VTD Series.
- E. Firestop Tracks: Top runner manufactured to allow partition heads to expand and contract with movement of the structure while maintaining continuity of fire-resistance-rated assembly indicated; in thickness not less than indicated for studs and in width to accommodate depth of studs.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. ClarkDietrich Metal Framing; SLP-TRK Slotted Deflection Track.
 - b. Fire Trak Corp.; Fire Trak System attached to studs with Fire Trak Posi Klip.
 - c. Grace Construction Products; FlameSafe FlowTrak System.
 - d. Metal-Lite, Inc.; The System.
- F. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated.
1. Minimum Base-Metal Thickness: 0.033 inch.
- G. Cold-Rolled Channel Bridging: Steel, 0.053-inch minimum base-metal thickness, with minimum 1/2-inch- wide flanges.

1. Depth: As indicated on Drawings.
2. Clip Angle: Not less than 1-1/2 by 1-1/2 inches, 0.068-inch- thick, galvanized steel.

H. Hat-Shaped, Rigid Furring Channels: ASTM C 645.

1. Minimum Base-Metal Thickness: 0.033 inch.
2. Depth: As indicated on Drawings.

I. Z-Shaped Furring: With slotted or nonslotted web, face flange of 1-1/4 inches, wall attachment flange of 7/8 inch, minimum uncoated-metal thickness of 0.018 inch, and depth required to fit insulation thickness indicated.

2.03 SUSPENSION SYSTEMS

- A. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.062-inch-diameter wire, or double strand of 0.048-inch- diameter wire.
- B. Wire Hangers: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.16 inch in diameter.
- C. Flat Hangers: Steel sheet, 1 by 3/16 inch by length indicated.
- D. Carrying Channels: Cold-rolled, commercial-steel sheet with a base-metal thickness of 0.053 inch and minimum 1/2-inch- wide flanges.
 1. Depth: 2-1/2 inches.

2.04 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with referenced installation standards.
 1. Fasteners for Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames, cast-in anchors, and structural framing, for compliance with requirements and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Suspended Assemblies: Coordinate installation of suspension systems with installation of overhead structure to ensure that inserts and other provisions for anchorages to building structure have been installed to receive hangers at spacing required to support the Work and that hangers will develop their full strength.
 1. Furnish concrete inserts and other devices indicated to other trades for installation in advance of time needed for coordination and construction.

3.03 INSTALLATION, GENERAL

- A. Installation Standard: ASTM C 754, except comply with framing sizes and spacing indicated.
 - 1. Gypsum Plaster Assemblies: Also comply with requirements in ASTM C 841 that apply to framing installation.
 - 2. Portland Cement Plaster Assemblies: Also comply with requirements in ASTM C 1063 that apply to framing installation.
 - 3. Gypsum Veneer Plaster Assemblies: Also comply with requirements in ASTM C 844 that apply to framing installation.
 - 4. Gypsum Board Assemblies: Also comply with requirements in ASTM C 840 that apply to framing installation.
- B. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.
- C. Install bracing at terminations in assemblies.
- D. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

3.04 INSTALLING FRAMED ASSEMBLIES

- A. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.
- B. Install studs so flanges within framing system point in same direction.
 - 1. Space studs as follows:
 - a. Single-Layer Application: 16 inches o.c. unless otherwise indicated.
 - b. Multilayer Application: 16 inches o.c. unless otherwise indicated.
 - c. Tile Backing Panels: 16 inches o.c. unless otherwise indicated.
- C. Install tracks (runners) at floors and overhead supports. Extend framing full height to structural supports or substrates above suspended ceilings, except where partitions are indicated to terminate at suspended ceilings. Continue framing around ducts penetrating partitions above ceiling.
 - 1. Slip-Type Head Joints: Where framing extends to overhead structural supports, install to produce joints at tops of framing systems that prevent axial loading of finished assemblies.
 - 2. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames; install runner track section (for cripple studs) at head and secure to jamb studs.
 - a. Install two studs at each jamb unless otherwise indicated.
 - b. Install cripple studs at head adjacent to each jamb stud, with a minimum 1/2-inch clearance from jamb stud to allow for installation of control joint in finished assembly.
 - c. Extend jamb studs through suspended ceilings and attach to underside of overhead structure.
 - 3. Other Framed Openings: Frame openings other than door openings the same as required for door openings unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.
 - 4. Fire-Resistance-Rated Partitions: Install framing to comply with fire-resistance-

rated assembly indicated and support closures and to make partitions continuous from floor to underside of solid structure.

- a. Firestop Track: Where indicated, install to maintain continuity of fire-resistance-rated assembly indicated.
5. Sound-Rated Partitions: Install framing to comply with sound-rated assembly indicated.
- D. Z-Furring Members:
1. Erect insulation (specified in Section 07 21 16 "Blanket Insulation") vertically and hold in place with Z-furring members spaced **16 inches** o.c.
 2. Except at exterior corners, securely attach narrow flanges of furring members to wall with concrete stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced **24 inches** o.c.
 3. At exterior corners, attach wide flange of furring members to wall with short flange extending beyond corner; on adjacent wall surface, screw-attach short flange of furring channel to web of attached channel. At interior corners, space second member no more than **12 inches** from corner and cut insulation to fit.
- E. Installation Tolerance: Install each framing member so fastening surfaces vary not more than **1/8 inch** from the plane formed by faces of adjacent framing.

3.05 INSTALLING SUSPENSION SYSTEMS

- A. Install suspension system components in sizes and spacings indicated on Drawings, but not less than those required by referenced installation standards for assembly types and other assembly components indicated.
- B. Isolate suspension systems from building structure where they abut or are penetrated by building structure to prevent transfer of loading imposed by structural movement.
- C. Suspend hangers from building structure as follows:
1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or suspension system.
 - a. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
 2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with locations of hangers required to support standard suspension system members, install supplemental suspension members and hangers in the form of trapezes or equivalent devices.
 - a. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced installation standards and California requirements.
 3. Wire Hangers: Secure by looping and wire tying, either directly to structures or to inserts, eye screws, or other devices and fasteners that are secure and appropriate for substrate, and in a manner that will not cause hangers to deteriorate or otherwise fail.
 4. Flat Hangers: Secure to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices and fasteners that are secure and appropriate for structure and hanger, and in a manner that will not cause

-
- hangers to deteriorate or otherwise fail.
5. Do not attach hangers to steel roof deck.
 6. Do not attach hangers to permanent metal forms. Furnish cast-in-place hanger inserts that extend through forms.
 7. Do not attach hangers to rolled-in hanger tabs of composite steel floor deck.
 8. Do not connect or suspend steel framing from ducts, pipes, or conduit.
- D. Fire-Resistance-Rated Assemblies: Wire tie furring channels to supports.
- E. Seismic Bracing: Sway-brace suspension systems with hangers used for support.
- F. Grid Suspension Systems: Attach perimeter wall track or angle where grid suspension systems meet vertical surfaces. Mechanically join main beam and cross-furring members to each other and butt-cut to fit into wall track.
- G. Installation Tolerances: Install suspension systems that are level to within **1/8 inch in 12 feet** measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.

END OF SECTION 09 22 16

SECTION 09 29 00**GYPSUM BOARD****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section Includes:

1. Interior gypsum board.
2. Tile backing panels

Gypsum Board Type	Room Name & Number	Comply with partition type for thickness and fire resistance using one of the following
INTERIOR & SPECIALTY GYPSUM BOARD		
Gypsum Board	As indicated on partition type unless noted otherwise in column below	Gypsum Board, Type X, 5/8 inch Thickness
Moisture- and Mold-Resistant Gypsum Board	Toilet and Bath Rooms	Moisture- and Mold-Resistant Gypsum Board, 5/8 inch thick Core, Type X
TILE BACKING PANELS		
Glass-Mat, Water-Resistant Backing Board	Shower surrounds	Glass-Mat, Water-Resistant Backing Board, 5/8 inch thick, Type X, Mold Resistant
Moisture- and Mold-Resistant Gypsum Backing Board	Toilet and Bath Rooms	Moisture- and Mold-Resistant Gypsum Board, 5/8 inch thick Core, Type X

- B. Related Requirements:

1. Section 06 16 00 "Sheathing" for gypsum sheathing for exterior walls.
2. Section 09 22 16 "Non-Structural Metal Framing" for non-structural framing and suspension systems that support gypsum board panels.

1.03 SUBMITTALS

- A. Product Data: For each type of product.

B. LEED Submittals:

1. Product Certificates for Credit MR 5: For products and materials required to comply with requirements for regional materials, certificates indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include statement indicating distance to Project, cost for each regional material, and fraction by weight that is considered regional.
2. Product Data for Credit IEQ 4.1: For adhesives used to laminate gypsum board panels to substrates, documentation including printed statement of VOC content.

C. Samples: For the following products:

1. Trim Accessories: Full-size Sample in 12-inch- long length for each trim accessory indicated.

1.04 QUALITY ASSURANCE**A. Mockups: Before beginning gypsum board installation, install mockups of at least 100 sq. ft. in surface area to demonstrate aesthetic effects and set quality standards for materials and execution.**

1. Install mockups for the following:
 - a. Each level of gypsum board finish indicated for use in exposed locations.
2. Apply or install final decoration indicated, including painting and wallcoverings, on exposed surfaces for review of mockups.
3. Simulate finished lighting conditions for review of mockups.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.05 DELIVERY, STORAGE AND HANDLING**A. Store materials inside under cover and keep them dry and protected against weather, condensation, direct sunlight, construction traffic, and other potential causes of damage. Stack panels flat and supported on risers on a flat platform to prevent sagging.****1.06 FIELD CONDITIONS**

- A. Environmental Limitations: Comply with ASTM C 840 requirements or gypsum board manufacturer's written recommendations, whichever are more stringent.**
- B. Do not install paper-faced gypsum panels until installation areas are enclosed and conditioned.**
- C. Do not install panels that are wet, those that are moisture damaged, and those that are mold damaged.**
 1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
 2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing agency.
- B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.

2.02 GYPSUM BOARD, GENERAL

- A. Regional Materials: Gypsum panel products shall be manufactured within **500 miles** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **500 miles** of Project site.
- B. Size: Provide maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.

2.03 INTERIOR GYPSUM BOARD

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. CertainTeed Corp.
 - 2. Georgia-Pacific Gypsum LLC.
 - 3. Lafarge North America Inc.
 - 4. National Gypsum Company.
 - 5. USG Corporation.
- B. Gypsum Board, Type X: ASTM C 1396/C 1396M.
 - 1. Thickness: **5/8 inch**.
 - 2. Long Edges: Tapered and featured (rounded or beveled) for prefilling.
- C. Gypsum Ceiling Board: ASTM C 1396/C 1396M.
 - 1. Thickness: **1/2 inch**.
 - 2. Long Edges: Tapered.
- D. Moisture- and Mold-Resistant Gypsum Board: ASTM C 1396/C 1396M. With moisture- and mold-resistant core and paper surfaces.
 - 1. Core: **5/8 inch**, Type X, except where **1/2 inch**, regular type is indicated on Drawings.
 - 2. Long Edges: Tapered.
 - 3. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.

2.04 TILE BACKING PANELS

- A. Glass-Mat, Water-Resistant Backing Board: ASTM C 1178/C 1178M, with manufacturer's standard edges.

1. Products: Subject to compliance with requirements, provide one of the following:
 - a. CertainTeed Corp.; GlasRoc Tile Backer.
 - b. Georgia-Pacific Gypsum LLC; DensShield Tile Backer.
2. Core: 5/8 inch, Type X, except where 1/2 inch, regular type is indicated on Drawings.
3. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.

2.05 TRIM ACCESSORIES

- A. Interior Trim: ASTM C 1047.
 1. Material: Galvanized or aluminum-coated steel sheet, rolled zinc, plastic, or paper-faced galvanized steel shee.
 2. Shapes:
 - a. Cornerbead.
 - b. Bullnose bead.
 - c. LC-Bead: J-shaped; exposed long flange receives joint compound.
 - d. L-Bead: L-shaped; exposed long flange receives joint compound.
 - e. U-Bead: J-shaped; exposed short flange does not receive joint compound.
 - f. Expansion (control) joint.
 - g. Curved-Edge Cornerbead: With notched or flexible flanges.
- B. Aluminum Trim: Extruded accessories of profiles and dimensions indicated.
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Fry Reglet Corp.
 - b. Gordon, Inc.
 - c. Pittcon Industries.
 2. Aluminum: Alloy and temper with not less than the strength and durability properties of [ASTM B 221](#), Alloy 6063-T5.
 3. Finish: Corrosion-resistant primer compatible with joint compound and finish materials specified.

2.06 JOINT TREATMENT MATERIALS

- A. General: Comply with ASTM C 475/C 475M.
- B. Joint Tape:
 1. Interior Gypsum Board: Paper.
 2. Tile Backing Panels: As recommended by panel manufacturer.
- C. Joint Compound for Interior Gypsum Board: For each coat use formulation that is compatible with other compounds applied on previous or for successive coats.
 1. Prefilling: At open joints, and damaged surface areas, use setting-type taping compound.
 2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use drying-type, all-purpose compound.
 3. Fill Coat: For second coat, use drying-type, all-purpose compound.

4. Finish Coat: For third coat, use drying-type, all-purpose compound.

D. Joint Compound for Tile Backing Panels:

1. Moisture- and Mold-Resistant Gypsum Backing Board: Use setting-type taping compound and setting-type, sandable topping compound.

2.07 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written recommendations.

B. Steel Drill Screws: ASTM C 1002, unless otherwise indicated.

1. Use screws complying with ASTM C 954 for fastening panels to steel members from 0.033 to 0.112 inch thick.
2. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.

C. Sound Attenuation Blankets: ASTM C 665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.

1. Fire-Resistance-Rated Assemblies: Comply with mineral-fiber requirements of assembly.
2. Recycled Content of Blankets: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 50 percent.

D. Acoustical Joint Sealant: Manufacturer's standard nonsag, paintable, nonstaining latex sealant complying with ASTM C 834. Product effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Accumetric LLC; BOSS 824 Acoustical Sound Sealant.
 - b. Grabber Construction Products; Acoustical Sealant GSC.
 - c. Pecora Corporation; AIS-919.
 - d. Specified Technologies, Inc.; Smoke N Sound Acoustical Sealant.
 - e. USG Corporation; SHEETROCK Acoustical Sealant.
2. Acoustical joint sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

E. Thermal Insulation: As specified in Section 07 21 00 "Blanket Insulation."

F. Vapor Retarder: As specified in Section 07 21 00 "Blanket Insulation."

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine areas and substrates including welded hollow-metal frames and framing, with Installer present, for compliance with requirements and other conditions affecting performance.

- B. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 APPLYING AND FINISHING PANELS, GENERAL

- A. Comply with ASTM C 840.
- B. Install ceiling panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.
- C. Install panels with face side out. Butt panels together for a light contact at edges and ends with not more than $1/16$ inch of open space between panels. Do not force into place.
- D. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.
- E. Form control and expansion joints with space between edges of adjoining gypsum panels.
- F. Cover both faces of support framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.
 - 1. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. in area.
 - 2. Fit gypsum panels around ducts, pipes, and conduits.
 - 3. Where partitions intersect structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by structural members; allow $1/4$ - to $3/8$ -inch- wide joints to install sealant.
- G. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments, except floors. Provide $1/4$ - to $1/2$ -inch- wide spaces at these locations and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.
- H. Attachment to Steel Framing: Attach panels so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.
- I. Wood Framing: Install gypsum panels over wood framing, with floating internal corner construction. Do not attach gypsum panels across the flat grain of wide-dimension lumber, including floor joists and headers. Float gypsum panels over these members or provide control joints to counteract wood shrinkage.
- J. STC-Rated Assemblies: Seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C 919 and with manufacturer's written recommendations for locating edge trim and closing off sound-flanking paths around or through assemblies, including sealing partitions above acoustical ceilings.
- K. Install sound attenuation blankets before installing gypsum panels unless blankets are

readily installed after panels have been installed on one side.

3.03 APPLYING INTERIOR GYPSUM BOARD

A. Install interior gypsum board in the following locations:

1. Wallboard Type: As indicated on Drawing.
2. Type X: Where required for fire-resistance-rated assembly.
3. Ceiling Type: As indicated on Drawings.
4. Moisture- and Mold-Resistant Type: As indicated on Drawings.

B. Single-Layer Application:

1. On ceilings, apply gypsum panels before wall/partition board application to greatest extent possible and at right angles to framing unless otherwise indicated.
2. On partitions/walls, apply gypsum panels horizontally (perpendicular to framing) unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints.
 - a. Stagger abutting end joints not less than one framing member in alternate courses of panels.
 - b. At stairwells and other high walls, install panels horizontally unless otherwise indicated or required by fire-resistance-rated assembly.
3. On Z-furring members, apply gypsum panels vertically (parallel to framing) with no end joints. Locate edge joints over furring members.
4. Fastening Methods: Apply gypsum panels to supports with steel drill screws.

C. Multilayer Application:

1. On partitions/walls, apply gypsum board indicated for base layers and face layers vertically (parallel to framing) with joints of base layers located over stud or furring member and face-layer joints offset at least one stud or furring member with base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly. Stagger joints on opposite sides of partitions.
2. On Z-furring members, apply base layer vertically (parallel to framing) and face layer either vertically (parallel to framing) or horizontally (perpendicular to framing) with vertical joints offset at least one furring member. Locate edge joints of base layer over furring members.
3. Fastening Methods: Fasten base layers and face layers separately to supports with screws.

3.04 APPLYING TILE BACKING PANELS

- A. Glass-Mat, Water-Resistant Backing Panels: Comply with manufacturer's written installation instructions and install at showers, tubs, and where indicated. Install with [1/4-inch](#) gap where panels abut other construction or penetrations.
- B. Where tile backing panels abut other types of panels in same plane, shim surfaces to produce a uniform plane across panel surfaces.

3.05 INSTALLING TRIM ACCESSORIES

- A. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.

- B. Control Joints: Install control joints according to ASTM C 840 and in specific locations approved by Architect for visual effect.
- C. Interior Trim: Install in the following locations:
 - 1. Cornerbead: Use at outside corners
 - 2. LC-Bead: Use at exposed panel edges.
 - 3. L-Bead: Use where indicated
 - 4. U-Bead: Use at exposed panel edges.

3.06 FINISHING GYPSUM BOARD

- A. General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.
- B. Prefill open joints and damaged surface areas.
- C. Apply joint tape over gypsum board joints, except for trim products specifically indicated as not intended to receive tape.
- D. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C 840:
 - 1. Level 2: Panels that are substrate for tile.
 - 2. Level 4: At panel surfaces that will be exposed to view unless otherwise indicated.
 - a. Primer and its application to surfaces are specified in other Section 09 91 23 "Interior Painting." Level 5 is suitable for surfaces receiving gloss and semigloss enamels and other surfaces subject to severe lighting. It is considered a high-quality gypsum board finish.
 - 3. Level 5: Where indicated on Drawings.
 - a. Primer and its application to surfaces are specified in Section 09 91 23 "Interior Painting."
- E. Glass-Mat Faced Panels: Finish according to manufacturer's written instructions.
- F. Cementitious Backer Units: Finish according to manufacturer's written instructions.

3.07 PROTECTION

- A. Protect adjacent surfaces from drywall compound and promptly remove from floors and other non-drywall surfaces. Repair surfaces stained, marred, or otherwise damaged during drywall application.
- B. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.
- C. Remove and replace panels that are wet, moisture damaged, and mold damaged.
 - 1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
 - 2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION 09 29 00

SECTION 09 30 00**TILING****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY**A. Section Includes:**

- 1. Ceramic tile.
- 2. Porcelain tile.
- 3. Waterproof membrane.
- 4. Crack isolation membrane.
- 5. Metal edge strips.

B. Related Sections:

- 1. Section 07 92 00 "Joint Sealants" for sealing of expansion, contraction, control, and isolation joints in tile surfaces.
- 2. Section 09 29 00 "Gypsum Board" for glass-mat, water-resistant backer board.

1.03 DEFINITIONS

- A. General: Definitions in the ANSI A108 series of tile installation standards and in ANSI A137.1 apply to Work of this Section unless otherwise specified.
- B. ANSI A108 Series: ANSI A108.01, ANSI A108.02, ANSI A108.1A, ANSI A108.1B, ANSI A108.1C, ANSI A108.4, ANSI A108.5, ANSI A108.6, ANSI A108.8, ANSI A108.9, ANSI A108.10, ANSI A108.11, ANSI A108.12, ANSI A108.13, ANSI A108.14, ANSI A108.15, ANSI A108.16, and ANSI A108.17, which are contained in "American National Standard Specifications for Installation of Ceramic Tile."
- C. Module Size: Actual tile size plus joint width indicated.
- D. Face Size: Actual tile size, excluding spacer lugs.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. LEED Submittals:
 - 1. Product Data for Credit IEQ 4.1: For adhesives and sealants, documentation including printed statement of VOC content.
 - 2. Product Data for Credit IEQ 4.3: For adhesives and grouts, documentation including printed statement of VOC content.
 - 3. Product Data for Credit IEQ 4.3: For tile floors, documentation from an independent testing agency indicating compliance with the FloorScore Standard.

- C. Shop Drawings: Show locations of each type of tile and tile pattern. Show widths, details, and locations of expansion, contraction, control, and isolation joints in tile substrates and finished tile surfaces.
- D. Samples for Initial Selection: For each type of tile and grout indicated. Include Samples of accessories involving color selection.
- E. Samples for Verification:
 - 1. Full-size units of each type and composition of tile and for each color and finish required.
 - 2. Assembled samples mounted on a rigid panel, with grouted joints, for each type and composition of tile and for each color and finish required. Make samples at least 12 inches square, but not fewer than 4 tiles. Use grout of type and in color or colors approved for completed Work.
 - 3. Full-size units of each type of trim and accessory for each color and finish required.
 - 4. Metal edge strips in 6-inch lengths.

1.05 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Master Grade Certificates: For each shipment, type, and composition of tile, signed by tile manufacturer and Installer.
- C. Product Certificates: For each type of product, signed by product manufacturer.
- D. Material Test Reports: For each tile-setting and -grouting product.

1.06 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match and are from same production runs as products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Tile and Trim Units: Furnish quantity of full-size units equal to 3 percent of amount installed for each type, composition, color, pattern, and size indicated.
 - 2. Grout: Furnish quantity of grout equal to 3 percent of amount installed for each type, composition, and color indicated.

1.07 QUALITY ASSURANCE

- A. Source Limitations for Tile: Obtain tile from one source or producer.
 - 1. Obtain tile of each type and color or finish from same production run and of consistent quality in appearance and physical properties for each contiguous area.
- B. Source Limitations for Setting and Grouting Materials: Obtain ingredients of a uniform quality for each mortar, adhesive, and grout component from one manufacturer and each aggregate from one source or producer.
- C. Source Limitations for Other Products: Obtain each of the following products specified in this Section from a single manufacturer for each product:
 - 1. Waterproof membrane.
 - 2. Crack isolation membrane.

3. Joint sealants.
 4. Metal edge strips.
- D. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
1. Build mockup of each type of floor tile installation.
 2. Build mockup of each type of wall tile installation.
 3. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store packaged materials in original containers with seals unbroken and labels intact until time of use. Comply with requirements in ANSI A137.1 for labeling tile packages.
- B. Store tile and cementitious materials on elevated platforms, under cover, and in a dry location.
- C. Store aggregates where grading and other required characteristics can be maintained and contamination can be avoided.
- D. Store liquid materials in unopened containers and protected from freezing.
- E. Handle tile that has temporary protective coating on exposed surfaces to prevent coated surfaces from contacting backs or edges of other units. If coating does contact bonding surfaces of tile, remove coating from bonding surfaces before setting tile.

1.09 PROJECT CONDITIONS

- A. Environmental Limitations: Do not install tile until construction in spaces is complete and ambient temperature and humidity conditions are maintained at the levels indicated in referenced standards and manufacturer's written instructions.

PART 2 - PRODUCTS

2.01 PRODUCTS, GENERAL

- A. ANSI Ceramic Tile Standard: Provide tile that complies with ANSI A137.1 for types, compositions, and other characteristics indicated.
 1. Provide tile complying with Standard grade requirements unless otherwise indicated.
- B. ANSI Standards for Tile Installation Materials: Provide materials complying with ANSI A108.02, ANSI standards referenced in other Part 2 articles, ANSI standards referenced by TCA installation methods specified in tile installation schedules, and other requirements specified.
- C. FloorScore Compliance: Tile for floors shall comply with requirements of FloorScore Standard.
- D. Factory Blending: For tile exhibiting color variations within ranges, blend tile in factory and package so tile units taken from one package show same range in colors as those taken from other packages and match approved Samples.

- E. Mounting: For factory-mounted tile, provide back- or edge-mounted tile assemblies as standard with manufacturer unless otherwise indicated.
 - 1. Where tile is indicated for installation in wet areas, do not use back- or edge-mounted tile assemblies unless tile manufacturer specifies in writing that this type of mounting is suitable for installation indicated and has a record of successful in-service performance.
- F. Factory-Applied Temporary Protective Coating: Where indicated under tile type, protect exposed surfaces of tile against adherence of mortar and grout by precoating with continuous film of petroleum paraffin wax, applied hot. Do not coat unexposed tile surfaces.

2.02 TILE PRODUCTS

A. Tile Type WT-1

- 1. Basis-of-Design Product: Subject to compliance with requirements, provide products as listed on Finish Legend, or comparable product by one of the following:
 - a. American Olean; Division of Dal-Tile International Inc.
 - b. Daltile; Division of Dal-Tile International Inc.
 - c. Deutsche Steinzeug America, Inc.
 - d. Endicott Tile Ltd.; Endicott Clay Products Co.
 - e. Florida Brick & Clay Company Inc.
 - f. Florida Tile Industries, Inc.
 - g. Interceramic.
 - h. Metropolitan Ceramics.
 - i. Portobello America, Inc.
 - j. Quarry Tile Co.
 - k. Seneca Tiles, Inc.
 - l. Summitville Tiles, Inc.
 - m. United States Ceramic Tile Company.
- 2. Face Size: [As shown on Finish Legend](#).
- 3. Tile Color and Pattern: As indicated on Finish Legend.
- 4. Grout Color: As indicated on Finish Legend. Trim Units: Coordinated with sizes and coursing of adjoining flat tile where applicable and matching characteristics of adjoining flat tile. Provide shapes as follows, selected from manufacturer's standard shapes:

B. Tile Type WT-2.

- 1. Basis-of-Design Product: Subject to compliance with requirements, provide mosaic tiles as indicated on Finish Legend or comparable product by one of the following:
 - a. American Marazzi Tile, Inc.
 - b. Crossville, Inc.
 - c. Daltile; Division of Dal-Tile International Inc.
 - d. Laufen.
 - e. Lone Star Ceramics Company.
 - f. Grupo Porcelanite.
 - g. Portobello America, Inc.
 - h. Seneca Tiles, Inc.
 - i. United States Ceramic Tile Company.

2. Composition: Impervious natural clay or porcelain.
3. Tile Color and Pattern: As indicated on Finish Legend.
4. Grout Color: As indicated on Finish Legend.

C. Tile Type TF-1:

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Finish Legend or comparable product by one of the following:
 - a. American Marazzi Tile, Inc.
 - b. Daltile; Division of Dal-Tile International Inc.
 - c. Deutsche Steinzeug America, Inc.
 - d. Florida Tile Industries, Inc.
 - e. Florim USA.
 - f. Laufen.
 - g. Grupo Porcelanite.
 - h. Portobello America, Inc.
 - i. Seneca Tiles, Inc.
 - j. United States Ceramic Tile Company.
2. Tile Color and Pattern: As indicated on Finish Legend.
3. Grout Color: As indicated on Finish Legend.

2.03 WATERPROOF MEMBRANE

- A. General: Manufacturer's standard product selected from the following, that complies with ANSI A118.10 and is recommended by the manufacturer for the application indicated. Include reinforcement and accessories recommended by manufacturer.
- B. Chlorinated Polyethylene Sheet: Nonplasticized, chlorinated polyethylene faced on both sides with nonwoven polyester fabric; 0.030-inch nominal thickness.
 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Noble Company (The); Nobleseal TS.
- C. PVC Sheet: Two layers of PVC sheet heat-fused together and to facings of nonwoven polyester; 0.040-inch nominal thickness.
 1. Compotite Corporation; Composeal Gold.
- D. Polyethylene Sheet: Polyethylene faced on both sides with fleece webbing; 0.008-inch nominal thickness.
 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Schluter Systems L.P.; KERDI.
- E. Fabric-Reinforced, Modified-Bituminous Sheet: Self-adhering, SBS-modified-bituminous sheet with woven reinforcement facing; 0.040-inch nominal thickness.
 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

- a. National Applied Construction Products, Inc.; Strataflex.
- F. Fabric-Reinforced, Fluid-Applied Membrane: System consisting of liquid-latex rubber or elastomeric polymer and continuous fabric reinforcement.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Boiardi Products; a QEP company; Elastiment 344 Reinforced Waterproofing and Anti-Fracture/Crack Suppression Membrane.
 - b. Bonsal American; an Oldcastle company; B 6000 Waterproof Membrane with Glass Fabric.
 - c. Bostik, Inc.; Hydroment Blacktop 90210.
 - d. Custom Building Products; 9240 Waterproofing and Anti-Fracture Membrane.
 - e. Laticrete International, Inc.; Laticrete 9235 Waterproof Membrane.
 - f. MAPEI Corporation; Mapelastik HPG with MAPEI Fiberglass Mesh.
 - g. Mer-Kote Products, Inc.; Hydro-Guard 2000.
- G. Fluid-Applied Membrane: Liquid-latex rubber or elastomeric polymer.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Boiardi Products; a QEP company; Elastiment 644 Membrane Waterproofing System.
 - b. Bonsal American; an Oldcastle company; B 6000 Waterproof Membrane.
 - c. Bostik, Inc.; Durabond D-222 Duraguard Membrane.
 - d. C-Cure; Pro-Red Waterproofing Membrane 63.
 - e. Custom Building Products; Redgard Waterproofing and Crack Prevention Membrane.
 - f. Jamo Inc.; Waterproof.
 - g. Laticrete International, Inc.; Latapoxy 24hr HydroProofing.
 - h. MAPEI Corporation; Mapelastik HPG.
 - i. Southern Grouts & Mortars, Inc.; Southcrete 1100 Crack Suppression and Waterproofing.
 - j. TEC; a subsidiary of H. B. Fuller Company; HydraFlex - Waterproofing Crack Isolation Membrane.
- H. Latex-Portland Cement: Flexible mortar consisting of cement-based mix and latex additive.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Boiardi Products; a QEP company; Elastiment 323 Cement Based Waterproofing, Anti-Fracture/Crack Suppression Membrane.
 - b. C-Cure; UltraCure 971.
 - c. MAPEI Corporation; Mapelastik (PRP 315).
 - d. Southern Grouts & Mortars, Inc.; Southcrete 1100.
 - e. TEC; a subsidiary of H. B. Fuller Company; Triple Flex Waterproofing, Crack Isolation Membrane & Mortar.
- I. Urethane Waterproofing and Tile-Setting Adhesive: One-part, liquid-applied urethane, with a VOC content of 65 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24), in a consistency suitable for trowel application and intended for use as both waterproofing and tile-setting adhesive in a two-step process.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Bostik, Inc.; Hydroment Ultra-Set .

2.04 CRACK ISOLATION MEMBRANE

- A. General: Manufacturer's standard product, selected from the following, that complies with ANSI A118.12 for standard performance and is recommended by the manufacturer for the application indicated. Include reinforcement and accessories recommended by manufacturer.
- B. Chlorinated Polyethylene Sheet: Nonplasticized, chlorinated polyethylene faced on both sides with nonwoven polyester fabric; 0.030-inch nominal thickness.
 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Noble Company (The); Nobleseal CIS.
- C. Polyethylene Sheet: Polyethylene faced on both sides with fleece webbing; 0.008-inch nominal thickness.
 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Schluter Systems L.P.; KERDI.
- D. Corrugated Polyethylene: Corrugated polyethylene with dovetail-shaped corrugations and with anchoring webbing on the underside; 3/16-inch nominal thickness.
 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Schluter Systems L.P.; DITRA.
- E. Fabric-Reinforced, Modified-Bituminous Sheet: Self-adhering, modified-bituminous sheet with fabric reinforcement facing; 0.040-inch nominal thickness.
 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. MAPEI Corporation; Mapelastic SM.
 - b. National Applied Construction Products, Inc.; Strataflex.
- F. Fabric-Reinforced, Fluid-Applied Membrane: System consisting of liquid-latex rubber or elastomeric polymer and fabric reinforcement.
 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Boiardi Products; a QEP company; Elastiment 344 Reinforced Waterproofing and Anti-Fracture/Crack Suppression Membrane.
 - b. Bonsal American; an Oldcastle company; B 6000 Waterproof Membrane with Glass Fabric.
 - c. Bostik, Inc.; Hydroment Blacktop 90210.
 - d. Custom Building Products; 9240 Waterproofing and Anti-Fracture

- Membrane.
 - e. Laticrete International, Inc.; Laticrete Blue 92 Anti-Fracture Membrane.
 - f. MAPEI Corporation; Mapelastc HPG with MAPEI Fiberglass Mesh.
 - g. Mer-Kote Products, Inc.; Hydro-Guard 2000.
- G. Fluid-Applied Membrane: Liquid-latex rubber or elastomeric polymer.
- 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Bostik, Inc.; Durabond D-222 Duraguard Membrane.
 - b. Custom Building Products; Redgard Waterproofing and Crack Prevention Membrane.
 - c. Jamo Inc.; Waterproof.
 - d. Mer-Kote Products, Inc.; Fracture-Guard 5000.
 - e. Southern Grouts & Mortars, Inc.; Southcrete 1100 Crack Suppression and Waterproofing.
 - f. TEC; a subsidiary of H. B. Fuller Company; HydraFlex - Waterproofing Crack Isolation Membrane.
- H. Latex-Portland Cement: Flexible mortar consisting of cement-based mix and latex additive.
- 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. C-Cure; UltraCure 971.
 - b. MAPEI Corporation; Mapelastc (PRP 315).
 - c. TEC; a subsidiary of H. B. Fuller Company; Triple Flex Waterproofing, Crack Isolation Membrane & Mortar.
- I. Urethane Crack Isolation Membrane and Tile-Setting Adhesive: One-part, liquid-applied urethane, with a VOC content of 65 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24), in a consistency suitable for trowel application and intended for use as both waterproofing and tile-setting adhesive in a two-step process.
- 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Bostik, Inc.; Hydroment Ultra-Set.

2.05 SETTING MATERIALS

- A. Latex-Portland Cement Mortar (Thin Set): ANSI A118.4.
- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Boiardi Products; a QEP company.
 - b. Bonsal American; an Oldcastle company.
 - c. Bostik, Inc.
 - d. C-Cure.
 - e. Custom Building Products.
 - f. Jamo Inc.
 - g. Laticrete International, Inc.
 - h. MAPEI Corporation.

- i. Mer-Kote Products, Inc.
 - j. Southern Grouts & Mortars, Inc.
 - k. Summitville Tiles, Inc.
 - l. TEC; a subsidiary of H. B. Fuller Company.
2. For wall applications, provide mortar that complies with requirements for nonsagging mortar in addition to the other requirements in ANSI A118.4.

2.06 GROUT MATERIALS

- A. Sand-Portland Cement Grout: ANSI A108.10, composed of white or gray cement and white or colored aggregate as required to produce color indicated.
- B. Polymer-Modified Tile Grout: ANSI A118.7.
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Boiardi Products; a QEP company.
 - b. Bonsal American; an Oldcastle company.
 - c. Bostik, Inc.
 - d. C-Cure.
 - e. Custom Building Products.
 - f. Jamo Inc.
 - g. Laticrete International, Inc.
 - h. MAPEI Corporation.
 - i. Southern Grouts & Mortars, Inc.
 - j. Summitville Tiles, Inc.
 - k. TEC; a subsidiary of H. B. Fuller Company.

2.07 MISCELLANEOUS MATERIALS

- A. Trowelable Underlayments and Patching Compounds: Latex-modified, portland cement-based formulation provided or approved by manufacturer of tile-setting materials for installations indicated.
- B. Temporary Protective Coating: Either product indicated below that is formulated to protect exposed surfaces of tile against adherence of mortar and grout; compatible with tile, mortar, and grout products; and easily removable after grouting is completed without damaging grout or tile.
 1. Petroleum paraffin wax, fully refined and odorless, containing at least 0.5 percent oil with a melting point of 120 to 140 deg F per ASTM D 87.
 2. Grout release in form of manufacturer's standard proprietary liquid coating that is specially formulated and recommended for use as temporary protective coating for tile.
- C. Tile Cleaner: A neutral cleaner capable of removing soil and residue without harming tile and grout surfaces, specifically approved for materials and installations indicated by tile and grout manufacturers.
- D. Metal Edge Strips: Angle shape, height to match tile and setting-bed thickness, metallic or combination of metal and PVC or neoprene base, designed specifically for flooring applications; stainless-steel, ASTM A 666, 300 Series exposed-edge material. Provide RENO-RAMP by Schluter Systems.

- E. Grout Sealer: Manufacturer's standard product for sealing grout joints and that does not change color or appearance of grout.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Bonsal American; an Oldcastle company; Grout Sealer.
 - b. Bostik, Inc.; CeramaSeal Grout & Tile Sealer.
 - c. C-Cure; Penetrating Sealer 978.
 - d. Custom Building Products; Surfaceguard Sealer.
 - e. Jamo Inc.; Penetrating Sealer.
 - f. MAPEI Corporation; KER 004, Keraseal Penetrating Sealer for Unglazed Grout and Tile.
 - g. Southern Grouts & Mortars, Inc.; Silicone Grout Sealer.
 - h. Summitville Tiles, Inc.; SL-15, Invisible Seal Penetrating Grout and Tile Sealer.
 - i. TEC; a subsidiary of H. B. Fuller Company; TA-256 Penetrating Silicone Grout Sealer.

2.08 MIXING MORTARS AND GROUT

- A. Mix mortars and grouts to comply with referenced standards and mortar and grout manufacturers' written instructions.
- B. Add materials, water, and additives in accurate proportions.
- C. Obtain and use type of mixing equipment, mixer speeds, mixing containers, mixing time, and other procedures to produce mortars and grouts of uniform quality with optimum performance characteristics for installations indicated.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions where tile will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of installed tile.
 - 1. Verify that substrates for setting tile are firm, dry, clean, free of coatings that are incompatible with tile-setting materials including curing compounds and other substances that contain soap, wax, oil, or silicone; and comply with flatness tolerances required by ANSI A108.01 for installations indicated.
 - 2. Verify that concrete substrates for tile floors installed with thin-set mortar comply with surface finish requirements in ANSI A108.01 for installations indicated.
 - a. Verify that surfaces that received a steel trowel finish have been mechanically scarified.
 - b. Verify that protrusions, bumps, and ridges have been removed by sanding or grinding.
 - 3. Verify that installation of grounds, anchors, recessed frames, electrical and mechanical units of work, and similar items located in or behind tile has been completed.
 - 4. Verify that joints and cracks in tile substrates are coordinated with tile joint locations; if not coordinated, adjust joint locations in consultation with Architect.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Fill cracks, holes, and depressions in concrete substrates for tile floors installed with thin-set mortar with trowelable leveling and patching compound specifically recommended by tile-setting material manufacturer.
- B. Where indicated, prepare substrates to receive waterproofing by applying a reinforced mortar bed that complies with ANSI A108.1A and is sloped $\frac{1}{4}$ inch per foot toward drains.
- C. Blending: For tile exhibiting color variations, verify that tile has been factory blended and packaged so tile units taken from one package show same range of colors as those taken from other packages and match approved Samples. If not factory blended, either return to manufacturer or blend tiles at Project site before installing.
- D. Field-Applied Temporary Protective Coating: If indicated under tile type or needed to prevent grout from staining or adhering to exposed tile surfaces, precoat them with continuous film of temporary protective coating, taking care not to coat unexposed tile surfaces.

3.03 TILE INSTALLATION

- A. Comply with TCA's "Handbook for Ceramic Tile Installation" for TCA installation methods specified in tile installation schedules. Comply with parts of the ANSI A108 Series "Specifications for Installation of Ceramic Tile" that are referenced in TCA installation methods, specified in tile installation schedules, and apply to types of setting and grouting materials used.
 - 1. For the following installations, follow procedures in the ANSI A108 Series of tile installation standards for providing 95 percent mortar coverage:
 - a. Tile floors in wet areas.
 - b. Tile floors composed of tiles 8 by 8 inches or larger.
 - c. Tile floors composed of rib-backed tiles.
- B. Extend tile work into recesses and under or behind equipment and fixtures to form complete covering without interruptions unless otherwise indicated. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.
- C. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.
- D. Provide manufacturer's standard trim shapes where necessary to eliminate exposed tile edges.
- E. Jointing Pattern: Lay tile in grid pattern unless otherwise indicated. Lay out tile work and center tile fields in both directions in each space or on each wall area. Lay out tile work to minimize the use of pieces that are less than half of a tile. Provide uniform joint widths unless otherwise indicated.
 - 1. For tile mounted in sheets, make joints between tile sheets same width as joints within tile sheets so joints between sheets are not apparent in finished work.
 - 2. Where adjoining tiles on floor, base, walls, or trim are specified or indicated to be same size, align joints.

3. Where tiles are specified or indicated to be whole integer multiples of adjoining tiles on floor, base, walls, or trim, align joints unless otherwise indicated.
- F. Joint Widths: Unless otherwise indicated, install tile with the following joint widths:
 1. Ceramic Mosaic Tile: 1/16 inch.
 2. Glazed Wall Tile: 1/16 inch.
 - G. Lay out tile wainscots to dimensions indicated or to next full tile beyond dimensions indicated.
 - H. Expansion Joints: Provide expansion joints and other sealant-filled joints, including control, contraction, and isolation joints, where indicated. Form joints during installation of setting materials, mortar beds, and tile. Do not saw-cut joints after installing tiles.
 1. Where joints occur in concrete substrates, locate joints in tile surfaces directly above them.
 - I. Metal Edge Strips: Install where exposed edge of tile flooring meets other flooring that finishes below top of tile and no threshold is indicated.
 - J. Grout Sealer: Apply grout sealer to grout joints in tile floors according to grout-sealer manufacturer's written instructions. As soon as grout sealer has penetrated grout joints, remove excess sealer and sealer from tile faces by wiping with soft cloth.

3.04 WATERPROOFING INSTALLATION

- A. Install waterproofing to comply with ANSI A108.13 and manufacturer's written instructions to produce waterproof membrane of uniform thickness and bonded securely to substrate.
- B. Do not install tile or setting materials over waterproofing until waterproofing has cured and been tested to determine that it is watertight.

3.05 CRACK ISOLATION MEMBRANE INSTALLATION

- A. Install crack isolation membrane to comply with ANSI A108.17 and manufacturer's written instructions to produce membrane of uniform thickness and bonded securely to substrate.
- B. Do not install tile or setting materials over crack isolation membrane until membrane has cured.

3.06 CLEANING AND PROTECTING

- A. Cleaning: On completion of placement and grouting, clean all ceramic tile surfaces so they are free of foreign matter.
 1. Remove latex-portland cement grout residue from tile as soon as possible.
 2. Clean grout smears and haze from tile according to tile and grout manufacturer's written instructions but no sooner than 10 days after installation. Use only cleaners recommended by tile and grout manufacturers and only after determining that cleaners are safe to use by testing on samples of tile and other surfaces to be cleaned. Protect metal surfaces and plumbing fixtures from effects of cleaning. Flush surfaces with clean water before and after cleaning.

3. Remove temporary protective coating by method recommended by coating manufacturer and that is acceptable to tile and grout manufacturer. Trap and remove coating to prevent drain clogging.
- B. Protect installed tile work with kraft paper or other heavy covering during construction period to prevent staining, damage, and wear. If recommended by tile manufacturer, apply coat of neutral protective cleaner to completed tile walls and floors.
- C. Prohibit foot and wheel traffic from tiled floors for at least seven days after grouting is completed.
- D. Before final inspection, remove protective coverings and rinse neutral protective cleaner from tile surfaces.

3.07 INTERIOR TILE INSTALLATION SCHEDULE

- A. Interior Floor Installations, Concrete Subfloor:
 1. Tile Installation F113: Thin-set mortar; TCA F113.
 - a. Tile Type: FT-1.
 - b. Thin-Set Mortar: Latex-portland cement mortar.
 - c. Grout: Polymer-modified sanded grout.
 2. Tile Installation F122: Thin-set mortar on waterproof membrane for wet areas; TCA F122.
 - a. Tile Type: FT-1.
 - b. Thin-Set Mortar: Latex-portland cement mortar.
 - c. Grout: Polymer-modified sanded grout.
 3. Tile Installation F125A: Thin-set mortar on crack isolation membrane; TCA F125A.
 - a. Tile Type: FT-1.
 - b. Thin-Set Mortar: Latex-portland cement mortar.
 - c. Grout: Polymer-modified sanded grout.
- B. Interior Wall Installations, Metal Studs
 1. Tile Installation B420: Thin-set mortar on waterproof membrane on coated glass-mat, water-resistant backer board; TCA B420.
 - a. Tile Type: WT-1.
 - b. Thin-Set Mortar: Latex-portland cement mortar.
 - c. Grout: Polymer-modified sanded grout.
- C. Interior Wall Installations, Metal Studs or Furring:
 1. Tile Installation W245: Thin-set mortar on coated glass-mat, water-resistant gypsum backer board; TCA W245.
 - a. Tile Type: WT-1 or WT-2.
 - b. Thin-Set Mortar: Latex-portland cement mortar.
 - c. Grout: Polymer-modified unsanded grout.
- D. Shower Receptor and Wall Installations, Concrete or Masonry:

1. Tile Installation B422: Thin-set mortar on waterproof membrane with integrated bonding flange for bonded membranes; TCA B422.
 - a. Tile Type: WT-1.
 - b. Thin-Set Mortar: Latex-portland cement mortar.
 - c. Grout: Polymer-modified unsanded grout.

END OF SECTION 09 30 00

SECTION 09 51 13**ACOUSTICAL PANEL CEILINGS****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section includes acoustical panels and exposed suspension systems for ceilings.
- B. Products furnished, but not installed under this Section, include anchors, clips, and other ceiling attachment devices to be cast in concrete.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. LEED Submittals:
 - 1. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating costs for each product having recycled content.
 - 2. Product Data for Credit EQ 4.1: For sealants, documentation including printed statement of VOC content.
- C. Samples: For each exposed product and for each color and texture specified, 6 inches in size.
- D. Samples for Initial Selection: For components with factory-applied color finishes.
- E. Samples for Verification: For each component indicated and for each exposed finish required, prepared on Samples of size indicated below.
 - 1. Acoustical Panel: Set of 6-inch- square Samples of each type, color, pattern, and texture.
 - 2. Exposed Suspension-System Members, Moldings, and Trim: Set of 6-inch- long Samples of each type, finish, and color.

1.04 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Suspended ceiling components.
 - 2. Structural members to which suspension systems will be attached.
 - 3. Size and location of initial access modules for acoustical panels.
 - 4. Items penetrating finished ceiling including the following:
 - a. Lighting fixtures.
 - b. Air outlets and inlets.

- c. Speakers.
- d. Sprinklers.
- e. Access panels.

5. Perimeter moldings.

- B. Qualification Data: For testing agency.
- C. Product Test Reports: For each acoustical panel ceiling, for tests performed by manufacturer and witnessed by a qualified testing agency.
- D. Evaluation Reports: For each acoustical panel ceiling suspension system and anchor and fastener type, from ICC-ES.
- E. Field quality-control reports.

1.05 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For finishes to include in maintenance manuals.

1.06 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Acoustical Ceiling Panels: Full-size panels equal to 2 percent of quantity installed.
 - 2. Suspension-System Components: Quantity of each exposed component equal to 2 percent of quantity installed.
 - 3. Hold-Down Clips: Equal to 2 percent of quantity installed.

1.07 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to NVLAP for testing indicated.
- B. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
 - 1. Build mockup of typical ceiling area as shown on Drawings.
 - 2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Deliver acoustical panels, suspension-system components, and accessories to Project site in original, unopened packages and store them in a fully enclosed, conditioned space where they will be protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.
- B. Before installing acoustical panels, permit them to reach room temperature and a stabilized moisture content.
- C. Handle acoustical panels carefully to avoid chipping edges or damaging units in any way.

1.09 FIELD CONDITIONS

- A. Environmental Limitations: Do not install acoustical panel ceilings until spaces are enclosed and weatherproof, wet work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
 - 1. Pressurized Plenums: Operate ventilation system for not less than 48 hours before beginning acoustical panel ceiling installation.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame-Spread Index: Comply with ASTM E 1264 for Class A materials.
 - 2. Smoke-Developed Index: 50 or less.
- B. Fire-Resistance Ratings: Comply with ASTM E 119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

2.02 ACOUSTICAL PANELS, GENERAL

- A. Low-Emitting Materials: Acoustical panel ceilings shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- B. Source Limitations:
 - 1. Acoustical Ceiling Panel: Obtain each type from single source from single manufacturer.
 - 2. Suspension System: Obtain each type from single source from single manufacturer.
- C. Source Limitations: Obtain each type of acoustical ceiling panel and supporting suspension system from single source from single manufacturer.
- D. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 70 percent.
- E. Glass-Fiber-Based Panels: Made with binder containing no urea formaldehyde.
- F. Acoustical Panel Standard: Provide manufacturer's standard panels of configuration indicated that comply with ASTM E 1264 classifications as designated by types, patterns, acoustical ratings, and light reflectances unless otherwise indicated.
 - 1. Mounting Method for Measuring NRC: Type E-400; plenum mounting in which face of test specimen is 15-3/4 inches away from test surface according to ASTM E 795.
- G. Acoustical Panel Colors and Patterns: Match appearance characteristics indicated for each product type.

1. Where appearance characteristics of acoustical panels are indicated by referencing pattern designations in ASTM E 1264 and not manufacturers' proprietary product designations, provide products selected by Architect from each manufacturer's full range that comply with requirements indicated for type, pattern, color, light reflectance, acoustical performance, edge detail, and size.

2.03 ACOUSTICAL PANELS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product Optima by Armstrong, or a comparable product by one of the following:
 1. CertainTeed Corp.
 2. Chicago Metallic Corporation.
 3. USG Interiors, Inc.; Subsidiary of USG Corporation.
- B. ACT-1: Optima by Armstrong, 24x24
- C. Classification: Provide panels complying with ASTM E 1264 for type, form, and pattern as follows:
 1. Type and Form: Type XII, Form 2.
 2. Pattern: E (lightly textured).
- D. Color: White.
- E. LR: Not less than 0.90.
- F. NRC: Not less than 0.95.
- G. AC: Not less than 190
- H. Edge/Joint Detail: Tegular.
- I. Thickness: As indicated on Drawings.
- J. Broad Spectrum Antimicrobial Fungicide and Bactericide Treatment: Provide acoustical panels treated with manufacturer's standard antimicrobial formulation that inhibits fungus, mold, mildew, and gram-positive and gram-negative bacteria and showing no mold, mildew, or bacterial growth when tested according to ASTM D 3273 and evaluated according to ASTM D 327 or ASTM G 21.

2.04 METAL SUSPENSION SYSTEMS, GENERAL

- A. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
- B. Metal Suspension-System Standard: Provide manufacturer's standard direct-hung metal suspension systems of types, structural classifications, and finishes indicated that comply with applicable requirements in ASTM C 635/C 635M.
 1. High-Humidity Finish: Comply with ASTM C 635/C 635M requirements for "Coating Classification for Severe Environment Performance" where high-humidity finishes are indicated.
- C. Attachment Devices: Size for five times the design load indicated in ASTM C 635/C 635M, Table 1, "Direct Hung," unless otherwise indicated. Comply with seismic design requirements.

1. Anchors in Concrete: Anchors of type and material indicated below, with holes or loops for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to five times that imposed by ceiling construction, as determined by testing according to ASTM E 488 or ASTM E 1512 as applicable, conducted by a qualified testing and inspecting agency.
 - a. Type: Postinstalled bonded anchors.
 - b. Corrosion Protection: Carbon-steel components zinc plated to comply with ASTM B 633, Class Fe/Zn 5 for Class SC 1 service condition.
 - c. Corrosion Protection: Stainless-steel components complying with ASTM F 593 and ASTM F 594, Group 1 Alloy 304 or 316 for bolts; Alloy 304 or 316 for anchor.
 - d. Corrosion Protection: Components fabricated from nickel-copper-alloy rods complying with ASTM B 164 for UNS No. N04400 alloy.
 2. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to 10 times that imposed by ceiling construction, as determined by testing according to ASTM E 1190, conducted by a qualified testing and inspecting agency.
- D. Wire Hangers, Braces, and Ties: Provide wires complying with the following requirements:
1. Zinc-Coated, Carbon-Steel Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper.
 2. Stainless-Steel Wire: ASTM A 580/A 580M, Type 304, nonmagnetic.
 3. Size: Select wire diameter so its stress at three times hanger design load (ASTM C 635/C 635M, Table 1, "Direct Hung") will be less than yield stress of wire, but provide not less than 0.135-inch-diameter wire.
- E. Hanger Rods: Mild steel, zinc coated or protected with rust-inhibitive paint.
- F. Angle Hangers: Angles with legs not less than 7/8 inch wide; formed with 0.04-inch-thick, galvanized-steel sheet complying with ASTM A 653/A 653M, G90 coating designation; with bolted connections and 5/16-inch-diameter bolts.
- G. Seismic Stabilizer Bars: Manufacturer's standard perimeter stabilizers designed to accommodate seismic forces.
- H. Seismic Struts: Manufacturer's standard compression struts designed to accommodate seismic forces.
- I. Seismic Clips: Manufacturer's standard seismic clips designed and spaced to secure acoustical panels in place.
- J. Hold-Down Clips: Where indicated, provide manufacturer's standard hold-down clips spaced 24 inches o.c. on all cross tees.
- K. Impact Clips: Where indicated, provide manufacturer's standard impact-clip system designed to absorb impact forces against acoustical panels.

2.05 METAL SUSPENSION SYSTEM

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited

to, the following:

1. Armstrong World Industries, Inc.
 2. CertainTeed Corp.
 3. Chicago Metallic Corporation.
 4. USG Interiors, Inc.; Subsidiary of USG Corporation.
- B. Narrow-Face, Capped, Double-Web, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet; prepainted, electrolytically zinc coated, or hot-dip galvanized according to ASTM A 653/A 653M, not less than G30 coating designation; with prefinished 9/16-inch- wide metal caps on flanges.
1. Structural Classification: Heavy-duty system.
 2. End Condition of Cross Runners: Override (stepped) or butt-edge type.
 3. Face Design: Flanges formed with an integral center reveal.
 4. Cap Material: Steel cold-rolled sheet.
 5. Cap Finish: Painted in color as selected from manufacturer's full range.

2.06 METAL EDGE MOLDINGS AND TRIM

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Armstrong World Industries, Inc.
 2. CertainTeed Corp.
 3. Chicago Metallic Corporation.
 4. Fry Reglet Corporation.
 5. Gordon, Inc.
 6. USG Interiors, Inc.; Subsidiary of USG Corporation.
- B. Roll-Formed, Sheet-Metal Edge Moldings and Trim: Type and profile indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations that comply with seismic design requirements; formed from sheet metal of same material, finish, and color as that used for exposed flanges of suspension-system runners.
1. Provide manufacturer's standard edge moldings that fit acoustical panel edge details and suspension systems indicated and that match width and configuration of exposed runners unless otherwise indicated.
 2. For lay-in panels with reveal edge details, provide stepped edge molding that forms reveal of same depth and width as that formed between edge of panel and flange at exposed suspension member.
 3. For circular penetrations of ceiling, provide edge moldings fabricated to diameter required to fit penetration exactly.
- C. Provide Axiom 4 inch trim at all exposed suspension system edges.

2.07 ACOUSTICAL SEALANT

- A. Acoustical Sealant: Manufacturer's standard sealant complying with ASTM C 834 and effective in reducing airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.
1. Exposed and Concealed Joints: Nonsag, paintable, nonstaining latex sealant.
 2. Concealed Joints: Nondrying, nonhardening, nonskinning, nonstaining, gunnable, synthetic-rubber sealant.
 3. Acoustical sealant shall have a VOC content of 250 g/L or less when calculated

according to 40 CFR 59, Subpart D (EPA Method 24).

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, including structural framing to which acoustical panel ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and with requirements for installation tolerances and other conditions affecting performance of acoustical panel ceilings.
- B. Examine acoustical panels before installation. Reject acoustical panels that are wet, moisture damaged, or mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Measure each ceiling area and establish layout of acoustical panels to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width panels at borders, and comply with layout shown on reflected ceiling plans.

3.03 INSTALLATION

- A. General: Install acoustical panel ceilings to comply with ASTM C 636/C 636M and seismic design requirements indicated, according to manufacturer's written instructions and CISCA's "Ceiling Systems Handbook."
 1. Fire-Rated Assembly: Install fire-rated ceiling systems according to tested fire-rated design.
- B. Suspend ceiling hangers from building's structural members and as follows:
 1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
 2. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
 3. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension-system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices.
 4. Secure wire hangers to ceiling-suspension members and to supports above with a minimum of three tight turns. Connect hangers directly either to structures or to inserts, eye screws, or other devices that are secure and appropriate for substrate and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
 5. Secure flat, angle, channel, and rod hangers to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices that are secure and appropriate for both the structure to which hangers are attached and the type of hanger involved. Install hangers in a manner that will not cause them to deteriorate or fail due to age, corrosion, or elevated temperatures.
 6. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast-in-place hanger inserts, postinstalled mechanical or adhesive anchors, or power-actuated fasteners that extend through forms into concrete.

7. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.
 8. Do not attach hangers to steel deck tabs.
 9. Do not attach hangers to steel roof deck. Attach hangers to structural members.
 10. Space hangers not more than 48 inches o.c. along each member supported directly from hangers unless otherwise indicated; provide hangers not more than 8 inches from ends of each member.
 11. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications.
- C. Secure bracing wires to ceiling suspension members and to supports with a minimum of four tight turns. Suspend bracing from building's structural members as required for hangers, without attaching to permanent metal forms, steel deck, or steel deck tabs. Fasten bracing wires into concrete with cast-in-place or postinstalled anchors.
- D. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical panels.
1. Apply acoustical sealant in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.
 2. Screw attach moldings to substrate at intervals not more than 16 inches o.c. and not more than 3 inches from ends, leveling with ceiling suspension system to a tolerance of 1/8 inch in 12 feet. Miter corners accurately and connect securely.
 3. Do not use exposed fasteners, including pop rivets, on moldings and trim.
- E. Install suspension-system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.
- F. Install acoustical panels with undamaged edges and fit accurately into suspension-system runners and edge moldings. Scribe and cut panels at borders and penetrations to provide a neat, precise fit.
1. Arrange directionally patterned acoustical panels as follows:
 - a. As indicated on reflected ceiling plans.
 - b. Install panels with pattern running in one direction parallel to long short axis of space.
 - c. Install panels in a basket-weave pattern.
 2. For square-edged panels, install panels with edges fully hidden from view by flanges of suspension-system runners and moldings.
 3. For reveal-edged panels on suspension-system runners, install panels with bottom of reveal in firm contact with top surface of runner flanges.
 4. For reveal-edged panels on suspension-system members with box-shaped flanges, install panels with reveal surfaces in firm contact with suspension-system surfaces and panel faces flush with bottom face of runners.
 5. Paint cut edges of panel remaining exposed after installation; match color of exposed panel surfaces using coating recommended in writing for this purpose by acoustical panel manufacturer.
 6. Install hold-down impact clips in areas indicated, in areas required by authorities having jurisdiction, and for fire-resistance ratings; space as recommended by panel manufacturer's written instructions unless otherwise indicated.
 7. Install clean-room gasket system in areas indicated, sealing each panel and fixture as recommended by panel manufacturer's written instructions.
 8. Protect lighting fixtures and air ducts to comply with requirements indicated for fire-resistance-rated assembly.

3.04 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:
 - 1. Compliance of seismic design.
- B. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections and prepare test reports.
- C. Perform the following tests and inspections of completed installations of acoustical panel ceiling hangers and anchors and fasteners in successive stages. Do not proceed with installations of acoustical panel ceiling hangers for the next area until test results for previously completed installations show compliance with requirements.
 - 1. Extent of Each Test Area: When installation of ceiling suspension systems on each floor has reached 20 percent completion but no panels have been installed.
 - a. Within each test area, testing agency will select one of every 10 power-actuated fasteners and postinstalled anchors used to attach hangers to concrete and will test them for 200 lbf of tension; it will also select one of every two postinstalled anchors used to attach bracing wires to concrete and will test them for 440 lbf of tension.
 - b. When testing discovers fasteners and anchors that do not comply with requirements, testing agency will test those anchors not previously tested until 20 pass consecutively and then will resume initial testing frequency.
- D. Acoustical panel ceiling hangers and anchors and fasteners will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports.

3.05 CLEANING

- A. Clean exposed surfaces of acoustical panel ceilings, including trim, edge moldings, and suspension-system members. Comply with manufacturer's written instructions for cleaning and touchup of minor finish damage. Remove and replace ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

END OF SECTION 09 51 13

SECTION 09 61 13**CAST IN PLACE (CIP) TACTILE WARNING SURFACE TILES****PART I – GENERAL****1.1 SUMMARY****A. Description**

The work of this Section includes installation of tactile warning material on station platforms. These materials shall consist of a tactile tile cast into Portland Cement Concrete surfaces at the following locations:

1. Edge of platform

1.2 RELATED SECTIONS**A. Section 13 13 50 Station Platforms****1.3 SUBMITTALS**

- Submit two copies of manufacturer's literature for all products furnished, including appropriate Material Safety Data Sheets (MSDS) to Architect.
- Submit representative samples of all materials including any required mortars, grouts, or recommended repair materials to Architect and client for approval.
- Submit representative color samples to Architect and client for approval.

1.4 QUALITY CONTROL

- Quality control shall be made in accordance with the requirements of the General Provisions, except as modified herein.
- Engage an experienced installer (either as a direct employee or as a subcontractor) who has completed warning strip installations similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.
- Source or brands of mortar, grout or admixture materials shall not be changed during the course of the Work. Obtain each color and type of joint and setting materials from a single source with resources to provide products and materials of consistent quality in appearance and physical properties without delaying the work.

1.5 DELIVERY, STORAGE AND HANDLING

- Tactile warning materials shall be protected during storage and construction against wetting by rain, snow or ground water and against spoilage or intermixture with earth or other types of materials. Wrap materials in plastic or use other packaging materials that will prevent rust marks from steel strapping.
- Grout and mortar materials shall be protected from deterioration by moisture and temperature. Contractor shall store in a dry location or in waterproof containers. Containers shall be kept tightly closed and away from open flames. Liquid components

shall be protected from freezing. Comply with manufacturer's recommendations for storage if more stringent, and with minimum and maximum storage temperature requirements.

- C. Protect stored materials from discoloration due to differential light exposure.

1.6 PROJECT CONDITIONS

A. Pre-Installation Conference

1. Before beginning tactile warning strip and associated work, the Subcontractor, with concrete foreman, shall meet at the Project site with the Contractor's Superintendent, the installer of each component of the associated work, the representatives of the warning strip manufacturer, installers of other work requiring coordination with warning strip work and the Engineer for a pre-installation conference.
2. The material selections and procedures to be followed in performing the work shall be reviewed to verify compliance with the requirements specified.
3. Expansion joint materials compatibility shall be verified to meet requirements herein.
4. If either the concrete foreman or Contractor's Superintendent are replaced before completion of work of this Section, the conference shall be repeated.

B. Frozen Work

1. Frozen materials or materials mixed or coated with ice or frost shall not be used.
2. Tactile warning strip work damaged by frost or freezing shall be removed and replaced at no cost to the Owner.

PART II - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. ADA Solutions,
- B. Engineered Plastics - Armor Tile,
- C. or approved equals.

2.2 MATERIALS

- A. Standard manufactured cast-in-place tiles
- B. Nominal tile dimensions shall be 24"x24"- w/ 2.35" o.c. dome spacing

2.3 SUPPLEMENTAL MATERIALS

- A. Other materials used in the installation shall be as approved by tile manufacturer.

PART III – EXECUTION

3.1 TRAINED AND CERTIFIED BY THE MANUFACTURER

- A. Acceptable installers shall be trained and certified by the manufacturer.

3.2 INSTALLATION - CONCRETE PLATFORMS AND HIGH BLOCKS

- A. Tactile warning strips containing chips, cracks and other defects that may be detrimental

to the safety or aesthetic qualities of the finished job or are out of dimensional requirements shall not be used.

1. Tiles shall not vary from sizes stated in subparagraphs of Paragraph 2.2 by more than plus or minus 1/8 inch.
- B. Tactile warning strips shall be cut with motor-driven saw equipment, only, designed to cut tactile warning strips with clean, sharp, unchipped edges. Warning strips shall be cut as required to provide the pattern shown and to fit adjoining work neatly. Full warning strips shall be used without cutting wherever possible. Where cutting is required, the largest tactile warning strip possible shall be used with no cutting through raised domes.
- C. Before initial set of concrete bed occurs, tactile warning strips shall be placed. Tactile warning strips shall be tamped and beat in for a complete contact with setting bed. Each tactile warning strip shall be set and leveled in a single operation.
1. Tactile warning strips shall be set in pattern shown on Contract Drawings with varying joint widths as necessary to align the centerlines of joints with a 1'-0" module and with the centerlines of concrete scoring joints, concrete construction joints, concrete control joints, and concrete expansion joints.
 2. Tactile warning strips shall be placed firmly on the concrete bed in a manner assuring a minimum of 95% contact. Surface plane of the tactile warning strips shall not vary more than 1/8 inch plus or minus from the designed grade at any point.
- D. Install expansion joints where warning strips abut restraining surfaces, such as perimeter walls, curbs, columns, wall corners, and directly over cold joints (pour joints) and control joints in structural surfaces. Conform to Contract Drawings, requirements of this Section, and the requirements of Section 07 92 13. Protect and preserve the expansion joint sealant backer assembly. Take reasonable and extraordinary precautions required to protect, prevent damage, preserve, and maintain indicated alignment and grade.

3.4 FIELD QUALITY CONTROL

- A. Engineer shall be notified 7 days in advance of beginning or resuming work.
- B. The Contractor shall have each 200 square feet of tactile warning strips inspected by Engineer for conformance to this Contract.

3.4 ADJUSTING AND CLEANING

- A. Tactile warning strips which are loose, chipped, broken, stained or otherwise damaged, and warning strips which do not match adjoining warning strips, shall be removed and replaced. Warning strips which have exposed surfaces above or below adjacent warning strips shall also be removed and replaced. Replacement of tactile shall include the necessary removal and replacement of concrete surface necessary to match the remaining tile.
- B. New warning strips to match adjoining warning strips shall be furnished and installed in fresh mortar or grout, and shall be pointed to eliminate evidence of replacement.
- C. Remove excess cement paste from exposed tactile warning strip surfaces, wash and scrub clean.
- D. Provide final protection and maintain conditions in a manner acceptable to installer that ensures that tactile warning strip work is without damage or deterioration at the time of Substantial Completion.

PART IV - MEASUREMENT

4.1 Measurement – No Separate measurement will be made for Work described in this Section.

PART V - PAYMENT

5.1 Payment – Payment for items in this Section will be incidental to the Contract lump sum cost of the Station Stops.

END OF SECTION

SECTION 09 65 13**RESILIENT BASE AND ACCESSORIES****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section Includes:
 - 1. Resilient base.
 - 2. Resilient molding accessories.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. LEED Submittals:
 - 1. Product Data for Credit IEQ 4.1: For adhesives, documentation including printed statement of VOC content.
 - 2. Product Data for Credit IEQ 4.3: For adhesives, documentation including printed statement of VOC content.
 - 3. Product Data for Credit IEQ 4.3: For resilient stair accessories, documentation from an independent testing agency indicating compliance with the FloorScore standard.
- C. Samples: For each exposed product and for each color and texture specified, not less than 12 inches long.
- D. Samples for Initial Selection: For each type of product indicated.
- E. Samples for Verification: For each type of product indicated and for each color, texture, and pattern required in manufacturer's standard-size Samples, but not less than 12 inches long.
- F. Product Schedule: For resilient base and accessory products. Use same designations indicated on Drawings.

1.04 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Furnish not less than 10 linear feet for every 500 linear feet or fraction thereof, of each type, color, pattern, and size of resilient product installed.

1.05 QUALITY ASSURANCE

- A. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
 - 1. Coordinate mockups in this Section with mockups specified in other Sections.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Store resilient products and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F or more than 90 deg F.

1.07 FIELD CONDITIONS

- A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F or more than 95 deg F, in spaces to receive resilient products during the following time periods:
 - 1. 48 hours before installation.
 - 2. During installation.
 - 3. 48 hours after installation.
- B. After installation and until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F or more than 95 deg F.
- C. Install resilient products after other finishing operations, including painting, have been completed.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. FloorScore Compliance: Resilient base shall comply with requirements of FloorScore certification.
- B. Low-Emitting Materials: Flooring system shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.02 THERMOSET-RUBBER BASE

- A. Basis of Design: Subject to requirements, provide products as shown on Finish Legend or a comparable product by one of the following:
 - 1. Burke Mercer Flooring Products, Division of Burke Industries Inc.
 - 2. Flexco.
 - 3. Roppe Corporation, USA.
- B. Product Standard: ASTM F 1861, Type TS (rubber, vulcanized thermoset), Group I (solid, homogeneous).
 - 1. Style and Location:
 - a. Style A, Straight: Provide in areas with carpet.
 - b. Style B, Cove: Provide in areas with resilient flooring or with no applied floor finish.
- C. Thickness: 0.125 inch.
- D. Height: As indicated on Drawings.

- E. Lengths: Coils in manufacturer's standard length
- F. Outside Corners: Job formed or preformed.
- G. Inside Corners: Job formed or preformed.
- H. Colors: As indicated on Drawings.

2.03 VINYL MOLDING ACCESSORY

- A. Basis of Design: Subject to requirements, provide products as shown on Finish Legend or a comparable product by one of the following:
 - 1. Burke Mercer Flooring Products, Division of Burke Industries Inc.
 - 2. Flexco.
 - 3. Roppe Corporation, USA.
- B. Description: Vinyl reducer strip for resilient flooring.
- C. Profile and Dimensions: As indicated.
- D. Locations: Provide vinyl molding accessories in areas indicated.
- E. Colors and Patterns: As selected by Architect from full range of industry colors.

2.04 INSTALLATION MATERIALS

- A. Trowelable Leveling and Patching Compounds: Latex-modified, portland cement based or blended hydraulic-cement-based formulation provided or approved by resilient-product manufacturer for applications indicated.
- B. Adhesives: Water-resistant type recommended by resilient-product manufacturer for resilient products and substrate conditions indicated.
 - 1. Adhesives shall have a VOC content of 50 g/L or less.
- C. Metal Edge Strips: Extruded aluminum with mill finish of width shown, of height required to protect exposed edges of flooring, and in maximum available lengths to minimize running joints.
- D. Floor Polish: Provide protective, liquid floor-polish products recommended by resilient stair-tread manufacturer.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
 - 1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of resilient products.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

1. Installation of resilient products indicates acceptance of surfaces and conditions.

3.02 PREPARATION

- A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of resilient products.
- B. Concrete Substrates for Resilient Stair Accessories: Prepare horizontal surfaces according to ASTM F 710.
 1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
 2. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by manufacturer. Do not use solvents.
 3. Alkalinity and Adhesion Testing: Perform tests recommended by manufacturer. Proceed with installation only after substrate alkalinity falls within range on pH scale recommended by manufacturer in writing, but not less than 5 or more than 9 or 10. Insert number pH.
 4. Moisture Testing: Proceed with installation only after substrates pass testing according to manufacturer's written recommendations, but not less stringent than the following:
 - a. Perform anhydrous calcium chloride test according to ASTM F 1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. Insert rate in 24 hours.
 - b. Perform relative humidity test using in situ probes according to ASTM F 2170. Proceed with installation only after substrates have maximum 75. Insert number percent relative humidity level.
- C. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.
- D. Do not install resilient products until they are the same temperature as the space where they are to be installed.
 1. At least 48 hours in advance of installation, move resilient products and installation materials into spaces where they will be installed.
- E. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient products.

3.03 RESILIENT BASE INSTALLATION

- A. Comply with manufacturer's written instructions for installing resilient base.
- B. Apply resilient base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.
- C. Install resilient base in lengths as long as practical without gaps at seams and with tops of adjacent pieces aligned.
- D. Tightly adhere resilient base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.
- E. Do not stretch resilient base during installation.

- F. On masonry surfaces or other similar irregular substrates, fill voids along top edge of resilient base with manufacturer's recommended adhesive filler material.
- G. Preformed Corners: Install preformed corners before installing straight pieces.
- H. Job-Formed Corners:
 - 1. Outside Corners: Use straight pieces of maximum lengths possible and form with returns not less than 3 inches in length.
 - a. Form without producing discoloration (whitening) at bends.
 - 2. Inside Corners: Use straight pieces of maximum lengths possible and form with returns not less than 3 inches in length.
 - a. Miter or cope corners to minimize open joints.

3.04 RESILIENT ACCESSORY INSTALLATION

- A. Comply with manufacturer's written instructions for installing resilient accessories.
- B. Resilient Molding Accessories: Butt to adjacent materials and tightly adhere to substrates throughout length of each piece. Install reducer strips at edges of floor covering that would otherwise be exposed.

3.05 CLEANING AND PROTECTION

- A. Comply with manufacturer's written instructions for cleaning and protecting resilient products.
- B. Perform the following operations immediately after completing resilient-product installation:
 - 1. Remove adhesive and other blemishes from exposed surfaces.
 - 2. Sweep and vacuum horizontal surfaces thoroughly.
 - 3. Damp-mop horizontal surfaces to remove marks and soil.
- C. Protect resilient products from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.
- D. Floor Polish: Remove soil, visible adhesive, and surface blemishes from resilient stair treads before applying liquid floor polish.
 - 1. Apply [one] [two] [three] [Insert requirement] coat(s).
- E. Cover resilient products subject to wear and foot traffic until Substantial Completion.

END OF SECTION 09 65 13

SECTION 09 65 16**LINOLEUM SHEET FLOORING****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section Includes linoleum sheet flooring.
- B. Related Sections:
 - 1. Division 09 Section "Resilient Base and Accessories" for resilient base, reducer strips, and other accessories installed with linoleum floor covering.

1.03 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. LEED Submittals:
 - 1. Product Data for Credit MR 6.0: For linoleum flooring, including printed statement of costs for each rapidly renewable material.
 - 2. Product Data for Credit EQ 4.1: For adhesives, including printed statement of VOC content.
- C. Shop Drawings: For each type of floor covering. Include floor covering layouts, locations of seams, edges, columns, doorways, enclosing partitions, built-in furniture, cabinets, and cutouts.
 - 1. Show details of special patterns.
- D. Samples for Initial Selection: For each type of floor covering indicated.
 - 1. Include similar Samples of installation accessories involving color selection.
- E. Samples for Verification: In manufacturer's standard size, but not less than 6-by-9-inch sections of each color and pattern of floor covering required.
- F. Product Schedule: For floor covering. Use same designations indicated on Drawings.
- G. Qualification Data: For qualified Installer.
- H. Maintenance Data: For each type of floor covering to include in maintenance manuals.

1.04 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified installer who employs workers for this Project who are competent in techniques required by manufacturer for floor covering installation.

1. Engage an installer who employs workers for this Project who are trained or certified by manufacturer for installation techniques required.
- B. Fire-Test-Response Characteristics: As determined by testing identical products according to ASTM E 648 or NFPA 253 by a qualified testing agency.
 1. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.
- C. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
 1. Build mockups for floor coverings including accessories.
 - a. Size: Minimum 100 sq. ft. for each type, color, and pattern in locations directed by Architect.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Store floor coverings and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 65 deg F or more than 90 deg F.
 1. Sheet Flooring: Store rolls upright.

1.06 PROJECT CONDITIONS

- A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F or more than 95 deg F, in spaces to receive floor coverings during the following time periods:
 1. 72 hours before installation.
 2. During installation.
 3. 72 hours after installation.
- B. Until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F or more than 95 deg F .
- C. Close spaces to traffic during floor covering installation.
- D. Close spaces to traffic for 72 hours after floor covering installation.
- E. Install floor coverings after other finishing operations, including painting, have been completed.

1.07 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Sheet Flooring: Furnish not less than 10 linear feet for every 500 linear feet or fraction thereof, in roll form and in full roll width for each color, pattern, and type of sheet flooring installed.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Products: Subject to compliance with requirements, provide products indicated on Finish Legend or a comparable product by one of the following:
1. Armstrong World Industries, Inc.
 2. Forbo Flooring, Inc.
 3. Tarkett Inc.

2.02 LINOLEUM FLOOR COVERING

- A. Sheet Flooring: ASTM F 2034, Type I, linoleum sheet with backing.
1. Roll Size: In manufacturer's standard length by not less than 78 inches wide.
- B. Seaming Method: Standard.
- C. Thickness: 0.08 inch 0.10 inch 0.13 inch 0.16 inch 0.18 inch <Insert thickness>.
- D. Colors and Patterns: As indicated by manufacturer's designations.

2.03 INSTALLATION MATERIALS

- A. Trowelable Leveling and Patching Compounds: Latex-modified, portland cement based or blended hydraulic-cement-based formulation provided or approved by manufacturer for applications indicated.
- B. Adhesives: Water-resistant type recommended by manufacturer to suit products and substrate conditions indicated.
1. Use adhesives that have a VOC content of not more than 50 g/L <Insert requirement> when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. Floor Polish: Provide protective liquid floor polish products as recommended by manufacturer.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
- B. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of floor coverings.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of floor coverings.

- B. Concrete Substrates: Prepare according to ASTM F 710.
1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
 2. Remove substrate coatings and other substances that are incompatible with floor covering adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by manufacturer. Do not use solvents.
 3. Alkalinity and Adhesion Testing: Perform tests recommended by manufacturer. Proceed with installation only after substrates pass testing.
 4. Moisture Testing: Perform tests recommended by manufacturer and as follows. Proceed with installation only after substrates pass testing.
 - a. Perform anhydrous calcium chloride test, ASTM F 1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of [3 lb of water/1000 sq. ft.] [Insert emission] in 24 hours.
 - b. Perform relative humidity test using in situ probes, ASTM F 2170. Proceed with installation only after substrates have maximum [75 percent] [Insert acceptable percentage] relative humidity level measurement.
- C. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound and remove bumps and ridges to produce a uniform and smooth substrate.
- D. Do not install floor coverings until they are same temperature as space where they are to be installed.
1. Move floor coverings and installation materials into spaces where they will be installed at least 72 hours in advance of installation.
- E. Sweep and vacuum clean substrates to be covered by floor coverings immediately before installation.

3.03 INSTALLATION, GENERAL

- A. Comply with manufacturer's written instructions for installing floor coverings.
- B. Scribe and cut floor coverings to butt neatly and tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosings.
- C. Extend floor coverings into toe spaces, door reveals, closets, and similar openings.
- D. Maintain reference markers, holes, or openings that are in place or marked for future cutting by repeating on floor coverings as marked on subfloor. Use chalk or other nonpermanent marking device.
- E. Install floor coverings on covers for telephone and electrical ducts and similar items in finished floor areas. Maintain overall continuity of color and pattern between pieces of floor covering installed on covers and adjoining floor covering. Tightly adhere floor covering edges to substrates that abut covers and to cover perimeters.
- F. Adhere floor coverings to substrates using a full spread of adhesive applied to substrate to produce a completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.

3.04 LINOLEUM SHEET FLOORING INSTALLATION

- A. Unroll sheet floorings and allow them to stabilize before cutting and fitting.
- B. Lay out sheet floorings as follows:
 - 1. Maintain uniformity of floor covering direction.
 - 2. Minimize number of seams; place seams in inconspicuous and low-traffic areas, at least 6 inches away from parallel joints in floor covering substrates.
 - 3. Match edges of floor coverings for color shading at seams.
 - 4. Avoid cross seams.
 - 5. Eliminate deformations that result from hanging method used during drying process (stove bar marks).
- C. Integral-Flash-Cove Base: Cove linoleum floor covering [6 inches] [dimension indicated] [Insert dimension] up vertical surfaces. Support floor covering at horizontal and vertical junction with cove strip. Butt at top against cap strip.

3.05 CLEANING AND PROTECTION

- A. Comply with manufacturer's written instructions for cleaning and protection of floor coverings.
- B. Perform the following operations immediately after completing floor covering installation:
 - 1. Remove adhesive and other blemishes from exposed surfaces.
 - 2. Sweep and vacuum surfaces thoroughly.
 - 3. Damp-mop surfaces to remove marks and soil.
- C. Protect floor coverings from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.
- D. Floor Polish: Remove soil, visible adhesive, and surface blemishes from floor coverings before applying liquid floor polish.
 - 1. Apply [two] [three] [Insert requirement] coat(s).
- E. After allowing drying room film (yellow film caused by linseed oil oxidation) to disappear, cover floor coverings until Substantial Completion.

END OF SECTION 09 65 16

SECTION 09 65 19
RESILIENT TILE FLOORING**PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section Includes:
 - 1. Vinyl composition floor tile.
- B. Related Sections:
 - 1. Section 09 65 13 "Resilient Base and Accessories" for resilient base, reducer strips, and other accessories installed with resilient floor coverings.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For each type of floor tile. Include floor tile layouts, edges, columns, doorways, enclosing partitions, built-in furniture, cabinets, and cutouts.
 - 1. Show details of special patterns.
- C. Samples for Verification: Full-size units of each color and pattern of floor tile required.
- D. Product Schedule: For floor tile. Use same designations indicated on Drawings.

1.04 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.

1.05 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For each type of floor tile to include in maintenance manuals.

1.06 MATERIALS MAINTENANCE SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Floor Tile: Furnish 1 box for every 50 boxes or fraction thereof, of each type, color, and pattern of floor tile installed.

1.07 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified installer who employs workers for this Project who are competent in techniques required by manufacturer for floor tile installation indicated.

1. Engage an installer who employs workers for this Project who are trained or certified by manufacturer for installation techniques required.
- B. Fire-Test-Response Characteristics: As determined by testing identical products according to ASTM E 648 or NFPA 253 by a qualified testing agency.
 1. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.
- C. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
 1. Build mockups for floor tile including resilient base and accessories.
 - a. Size: Minimum 100 sq. ft. for each type, color, and pattern in locations directed by Architect.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Store floor tile and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F or more than 90 deg F. Store floor tiles on flat surfaces.

1.09 PROJECT CONDITIONS

- A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F or more than 95 deg F, in spaces to receive floor tile during the following time periods:
 1. 48 hours before installation.
 2. During installation.
 3. 48 hours after installation.
- B. Until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F or more than 95 deg F.
- C. Close spaces to traffic during floor tile installation.
- D. Close spaces to traffic for 48 hours after floor tile installation.
- E. Install floor tile after other finishing operations, including painting, have been completed.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. FloorScore Compliance: Resilient tile flooring shall comply with requirements of FloorScore Standard.

2.02 VINYL COMPOSITION FLOOR TILE VCT-1 and VCT-2

- A. Basis of Design: Subject to compliance with requirements, provide Cortina Grande by Azrock
- B. Tile Standard: ASTM F 1700, Class 1, Type A.
- C. Wearing Surface: Smooth.

- D. Thickness: 0.125 inch.
- E. Size: 16 by 16 inches.
- F. Colors and Patterns: As indicated by manufacturer's designations on Finish Legend

2.03 VINYL COMPOSITION FLOOR TILE VCT-3 and VCT-4

- A. Basis of Design: Subject to compliance with requirements, provide Striations by Armstrong Commercial Flooring.
- B. Tile Standard: ASTM F 1066, Class 2 - through pattern.
- C. Wearing Surface: Smooth.
- D. Thickness: 0.125 inch.
- E. Size: 12 by 24 inches.
- F. Colors and Patterns: As indicated by manufacturer's designations on Finish Legend

2.04 INSTALLATION MATERIALS

- A. Trowelable Leveling and Patching Compounds: Latex-modified, portland cement based or blended hydraulic-cement-based formulation provided or approved by manufacturer for applications indicated.
- B. Adhesives: Water-resistant type recommended by manufacturer to suit floor tile and substrate conditions indicated.
 - 1. Adhesives shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
 - a. VCT and Asphalt Tile Adhesives: Not more than 50 g/L.
 - 2. Adhesives shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- C. Seamless-Installation Accessories:
 - 1. Heat-Welding Bead: Manufacturer's solid-strand product for heat welding seams.
 - a. Color: Match floor tile.
- D. Floor Polish: Provide protective liquid floor polish products as recommended by manufacturer.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

- B. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of floor tile.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of resilient products.
- B. Concrete Substrates: Prepare according to ASTM F 710.
 - 1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
 - 2. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by manufacturer. Do not use solvents.
 - 3. Alkalinity and Adhesion Testing: Perform tests recommended by manufacturer. Proceed with installation only after substrates pass testing.
 - 4. Moisture Testing: Perform tests recommended by manufacturer and as follows. Proceed with installation only after substrates pass testing.
 - a. Perform anhydrous calcium chloride test, ASTM F 1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft in 24 hours.
 - b. Perform relative humidity test using in situ probes, ASTM F 2170. Proceed with installation only after substrates have a maximum 75 relative humidity level measurement.
- C. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound and remove bumps and ridges to produce a uniform and smooth substrate.
- D. Do not install floor tiles until they are same temperature as space where they are to be installed.
 - 1. Move resilient products and installation materials into spaces where they will be installed at least 48 hours in advance of installation.
- E. Sweep and vacuum clean substrates to be covered by resilient products immediately before installation.

3.03 FLOOR TILE INSTALLATION

- A. Comply with manufacturer's written instructions for installing floor tile.
- B. Lay out floor tiles from center marks established with principal walls, discounting minor offsets, so tiles at opposite edges of room are of equal width. Adjust as necessary to avoid using cut widths that equal less than one-half tile at perimeter.
 - 1. Lay tiles square with room axis.
- C. Match floor tiles for color and pattern by selecting tiles from cartons in the same sequence as manufactured and packaged, if so numbered. Discard broken, cracked, chipped, or deformed tiles.

1. Lay tiles with grain running in one direction.
- D. Scribe, cut, and fit floor tiles to butt neatly and tightly to vertical surfaces and permanent fixtures including built-in furniture, cabinets, pipes, outlets, and door frames.
- E. Extend floor tiles into toe spaces, door reveals, closets, and similar openings. Extend floor tiles to center of door openings.
- F. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on floor tiles as marked on substrates. Use chalk or other nonpermanent, nonstaining marking device.
- G. Install floor tiles on covers for telephone and electrical ducts, building expansion-joint covers, and similar items in finished floor areas. Maintain overall continuity of color and pattern between pieces of tile installed on covers and adjoining tiles. Tightly adhere tile edges to substrates that abut covers and to cover perimeters.
- H. Adhere floor tiles to flooring substrates using a full spread of adhesive applied to substrate to produce a completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.
- I. Seamless Installation:
 1. Heat-Welded Seams: Comply with ASTM F 1516. Rout joints and heat weld with welding bead to permanently fuse sections into a seamless floor covering. Prepare, weld, and finish seams to produce surfaces flush with adjoining floor covering surfaces.

3.04 CLEANING AND PROTECTION

- A. Comply with manufacturer's written instructions for cleaning and protection of floor tile.
- B. Perform the following operations immediately after completing floor tile installation:
 1. Remove adhesive and other blemishes from exposed surfaces.
 2. Sweep and vacuum surfaces thoroughly.
 3. Damp-mop surfaces to remove marks and soil.
- C. Protect floor tile products from marks, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.
- D. Floor Polish: Remove soil, visible adhesive, and surface blemishes from floor tile surfaces before applying liquid floor polish.
 1. Apply two coat(s).
- E. Cover floor tile until Substantial Completion.

END OF SECTION 09 65 19

SECTION 09 65 19.02**RECYCLED RUBBER TILE FLOORING****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section Includes rubber floor tile.
 - 1. Application: Elevator cab floor
- B. Related Sections:
 - 1. Section 14 21 24 Machine Room-Less Electric Traction Passenger Elevators.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. LEED Submittals:
 - 1. Product Data for Credit IEQ 4.1: For adhesives, sealants and chemical-bonding compounds, documentation including printed statement of VOC content.
 - 2. Product Data for Credit IEQ 4.3: For adhesives and chemical-bonding compounds, documentation including printed statement of VOC content.
 - 3. Product Data for Credit IEQ 4.3: For resilient tile flooring, documentation from an independent testing agency indicating compliance with the FloorScore Standard.
- C. Shop Drawings: For each type of floor tile. Include floor tile layouts, edges, columns, doorways, enclosing partitions, built-in furniture, cabinets, and cutouts.
 - 1. Show details of special patterns.
- D. Samples for Initial Selection: For each type of floor tile indicated.
- E. Samples for Verification: Full-size units of each color and pattern of floor tile required.
- F. Product Schedule: For floor tile. Use same designations indicated on Drawings.

1.04 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.

1.05 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For each type of floor tile to include in maintenance manuals.

1.06 MATERIALS MAINTENANCE SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Floor Tile: Furnish 1 box for every 50 boxes or fraction thereof, of each type, color, and pattern of floor tile installed.

1.07 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified installer who employs workers for this Project who are competent in techniques required by manufacturer for floor tile installation indicated.
 1. Engage an installer who employs workers for this Project who are trained or certified by manufacturer for installation techniques required.
- B. Fire-Test-Response Characteristics: As determined by testing identical products according to ASTM E 648 or NFPA 253 by a qualified testing agency.
 1. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Store floor tile and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F or more than 90 deg F. Store floor tiles on flat surfaces.

1.09 PROJECT CONDITIONS

- A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F or more than 95 deg F, in spaces to receive floor tile during the following time periods:
 1. 48 hours before installation.
 2. During installation.
 3. 48 hours after installation.
- B. Until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F or more than 95 deg F.
- C. Close spaces to traffic during floor tile installation.
- D. Close spaces to traffic for 48 hours after floor tile installation.
- E. Install floor tile after other finishing operations, including painting, have been completed.

PART 2 - PRODUCTS

2.01 RECYCLED RUBBER TIRE FLOOR TILE

- A. Basis of Design: Subject to requirements, provide Expanko Reztex Rubber Tile Flooring by Roppe Corporation.
- B. Size: 24 by 24 inches.
- C. Colors and Patterns: As indicated by manufacturer's designations.

2.02 INSTALLATION MATERIALS

- A. Trowelable Leveling and Patching Compounds: Latex-modified, portland cement based or blended hydraulic-cement-based formulation provided or approved by manufacturer for applications indicated.
- B. Adhesives: Water-resistant type recommended by manufacturer to suit floor tile and substrate conditions indicated.
 1. Adhesives shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
 - a. Rubber Floor Adhesives: Not more than 60 g/L.
 2. Adhesives shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
- B. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of floor tile.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of resilient products.
- B. Concrete Substrates: Prepare according to ASTM F 710.
 1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
 2. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by manufacturer. Do not use solvents.
 3. Alkalinity and Adhesion Testing: Perform tests recommended by manufacturer. Proceed with installation only after substrates pass testing.
 4. Moisture Testing: Perform tests recommended by manufacturer and as follows.
 - a. Perform anhydrous calcium chloride test, ASTM F 1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. in 24 hours.
 - b. Perform relative humidity test using in situ probes, ASTM F 2170. Proceed with installation only after substrates have a maximum 75 relative humidity level measurement.
- C. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound and remove bumps and ridges to produce a uniform and smooth

substrate.

- D. Do not install floor tiles until they are same temperature as space where they are to be installed.
 - 1. Move resilient products and installation materials into spaces where they will be installed at least 48 hours in advance of installation.
- E. Sweep and vacuum clean substrates to be covered by resilient products immediately before installation.

3.03 FLOOR TILE INSTALLATION

- A. Comply with manufacturer's written instructions for installing floor tile.
- B. Lay out floor tiles from center marks established with principal walls, discounting minor offsets, so tiles at opposite edges of room are of equal width. Adjust as necessary to avoid using cut widths that equal less than one-half tile at perimeter.
 - 1. Lay tiles square with room axis.
- C. Match floor tiles for color and pattern by selecting tiles from cartons in the same sequence as manufactured and packaged, if so numbered. Discard broken, cracked, chipped, or deformed tiles.
 - 1. Lay tiles with grain direction alternating in adjacent tiles (basket-weave pattern).
- D. Scribe, cut, and fit floor tiles to butt neatly and tightly to vertical surfaces and permanent fixtures including built-in furniture, cabinets, pipes, outlets, and door frames.
- E. Extend floor tiles into toe spaces, door reveals, closets, and similar openings. Extend floor tiles to center of door openings.
- F. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on floor tiles as marked on substrates. Use chalk or other nonpermanent, nonstaining marking device.
- G. Install floor tiles on covers for telephone and electrical ducts, building expansion-joint covers, and similar items in finished floor areas. Maintain overall continuity of color and pattern between pieces of tile installed on covers and adjoining tiles. Tightly adhere tile edges to substrates that abut covers and to cover perimeters.
- H. Adhere floor tiles to flooring substrates using a full spread of adhesive applied to substrate to produce a completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.

3.04 CLEANING AND PROTECTION

- A. Comply with manufacturer's written instructions for cleaning and protection of floor tile.
- B. Perform the following operations immediately after completing floor tile installation:
 - 1. Remove adhesive and other blemishes from exposed surfaces.
 - 2. Sweep and vacuum surfaces thoroughly.
 - 3. Damp-mop surfaces to remove marks and soil.

- C. Protect floor tile products from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.
- D. Cover floor tile until Substantial Completion.

END OF SECTION 09 65 19

SECTION 09 67 23
RESINOUS COATING**PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section Includes:
 - 1. Industrial resinous coating systems.
- B. Related Sections:
 - 1. Division 07 Section "Joint Sealants" for sealants installed at joints in resinous coating systems.

1.03 SUBMITTALS

- A. Product Data: For each type of product indicated. Include manufacturer's technical data, application instructions, and recommendations for each resinous coating component required.
- B. LEED Submittals:
 - 1. Product Data for Credit IEQ 4.2: For liquid-applied coating components, documentation including printed statement of VOC content.
- C. Samples for Initial Selection: For each type of exposed finish required.
- D. Samples for Verification: For each resinous coating system required, 6 inches square, applied to a rigid backing by Installer for this Project.
- E. Product Schedule: For resinous coating.
- F. Installer Certificates: Signed by manufacturer certifying that installers comply with specified requirements.
- G. Material Certificates: For each resinous coating component, from manufacturer.
- H. Material Test Reports: For each resinous coating system.
- I. Maintenance Data: For resinous coating to include in maintenance manuals.

1.04 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of coating systems required for this Project.
 - 1. Engage an installer who is certified in writing by resinous coating manufacturer as qualified to apply resinous coating systems indicated.

- B. Source Limitations: Obtain primary resinous coating materials, including primers, resins, hardening agents, grouting coats, and topcoats, from single source from single manufacturer. Provide secondary materials, including patching and fill material, joint sealant, and repair materials, of type and from source recommended by manufacturer of primary materials.
- C. Mockups: Apply mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
 - 1. Apply full-thickness mockups on 48-inch- square floor area selected by Architect.
 - a. Include 48-inch length of integral cove base with inside and outside corner.
 - 2. Simulate finished lighting conditions for Architect's review of mockups.
 - 3. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
- D. Preinstallation Conference: Conduct conference at Project site.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in original packages and containers, with seals unbroken, bearing manufacturer's labels indicating brand name and directions for storage and mixing with other components.

1.06 PROJECT CONDITIONS

- A. Environmental Limitations: Comply with resinous coating manufacturer's written instructions for substrate temperature, ambient temperature, moisture, ventilation, and other conditions affecting resinous coating application.
- B. Lighting: Provide permanent lighting or, if permanent lighting is not in place, simulate permanent lighting conditions during resinous coating application.
- C. Close spaces to traffic during resinous coating application and for not less than 24 hours after application unless manufacturer recommends a longer period.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. VOC Content of Liquid-Applied Coating Components: Not more than 100 g/L when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.02 INDUSTRIAL RESINOUS COATING

- A. Basis of Design: Provide Rhino Extreme FR 21-50 by Rhino Linings Corporation
- B. System Characteristics:
 - 1. Color and Pattern: As indicated by product designation listed on Finish Legend.
 - 2. Wearing Surface: Textured for slip resistance.
 - 3. Overall System Thickness: 1/16 inch minimum.
- C. System Physical Properties: Provide resinous coating system with the following minimum physical property requirements when tested according to test methods

indicated:

1. Shore Hardness: 45, plus or minus 5, per ASTM D-2240.
2. Tensile Strength: 1400-1600 per ASTM D-412.
3. Specific Gravity: 1.10 - 1.12 grams/cc per ASTM D-792.
4. Elongation: 250 - 300 percent per ASTM D-412
5. Water Absorption: 1.0 percent per ASTM D-570.
6. Flammability:
 - a. Pass per FMV-302
 - b. Pass per Cal 117
 - c. V-O per UL-94
7. Dielectric Strength: 300 volts/mil per ASTM D-149
8. Volume Resistancy: 6×10 ohm/inches per ASTM D-257
9. Dielectric Constant: 5.4 MHz per ASTM D-150
10. Dissipation Factor: 0.058 MHz per ASTM D-150
11. Cathodic Disbonding: Pass per ASTM G-8
12. Eclometer Adhesion Pull Test: Pass per ASTM D-4541

2.03 ACCESSORIES

- A. Primer: Type recommended by manufacturer for substrate and body coats indicated.
- B. Waterproofing Membrane: Type recommended by manufacturer for substrate and primer and body coats indicated.
 1. Formulation Description: High solids.
- C. Patching and Fill Material: Resinous product of or approved by resinous coating manufacturer and recommended by manufacturer for application indicated.

PART 3 - EXECUTION

3.01 PREPARATION

- A. General: Prepare and clean substrates according to resinous coating manufacturer's written instructions for substrate indicated. Provide clean, dry substrate for resinous coating application.
- B. Concrete Substrates: Provide sound concrete surfaces free of laitance, glaze, efflorescence, curing compounds, form-release agents, dust, dirt, grease, oil, and other contaminants incompatible with resinous coating.
 1. Roughen concrete substrates as follows:
 - a. Shot-blast surfaces with an apparatus that abrades the concrete surface, contains the dispensed shot within the apparatus, and recirculates the shot by vacuum pickup.
 - b. Comply with ASTM C 811 requirements unless manufacturer's written instructions are more stringent.
 2. Repair damaged and deteriorated concrete according to resinous coating manufacturer's written instructions.
 3. Verify that concrete substrates are dry and moisture-vapor emissions are within acceptable levels according to manufacturer's written instructions.

- a. Perform anhydrous calcium chloride test, ASTM F 1869. Proceed with application of resinous coating only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. of slab area in 24 hours.
 - b. Perform plastic sheet test, ASTM D 4263. Proceed with application only after testing indicates absence of moisture in substrates.
 - c. Perform relative humidity test using in situ probes, ASTM F 2170. Proceed with installation only after substrates have a maximum 75 percent relative humidity level measurement.
4. Alkalinity and Adhesion Testing: Verify that concrete substrates have pH within acceptable range. Perform tests recommended by manufacturer. Proceed with application only after substrates pass testing.
- C. Resinous Materials: Mix components and prepare materials according to resinous coating manufacturer's written instructions.
- D. Use patching and fill material to fill holes and depressions in substrates according to manufacturer's written instructions.
- E. Treat control joints and other nonmoving substrate cracks to prevent cracks from reflecting through resinous coating according to manufacturer's written instructions.

3.02 APPLICATION

- A. General: Apply components of resinous coating system according to manufacturer's written instructions to produce a uniform, monolithic wearing surface of thickness indicated.
1. Coordinate application of components to provide optimum adhesion of resinous coating system to substrate, and optimum intercoat adhesion.
 2. Cure resinous coating components according to manufacturer's written instructions. Prevent contamination during application and curing processes.
 3. At substrate expansion and isolation joints, comply with resinous coating manufacturer's written instructions.
- B. Apply primer over prepared substrate at manufacturer's recommended spreading rate.
- C. Apply reinforcing membrane to substrate cracks.
- D. Integral Cove Base and Wall Coating: Apply cove base mix to wall surfaces before applying coating. Apply according to manufacturer's written instructions and details including those for taping, mixing, priming, troweling, sanding, and topcoating of cove base. Round internal and external corners.
1. Integral Cove Base and Wall Coating: Extend to height indicated on Drawings.
- E. Apply self-leveling slurry body coats in thickness indicated for coating system.
1. Broadcast aggregates at rate recommended by manufacturer and, after resin is cured, remove excess aggregates to provide surface texture indicated.
- F. Apply troweled or screeded body coats in thickness indicated for coating system. Hand or power trowel and grout to fill voids. When cured, remove trowel marks and roughness using method recommended by manufacturer.
- G. Apply grout coat, of type recommended by resinous coating manufacturer, to fill voids

in surface of final body coat and to produce wearing surface indicated.

- H. Apply topcoats in number indicated for coating system and at spreading rates recommended in writing by manufacturer.

3.03 FIELD QUALITY CONTROL

- A. Core Sampling: At the direction of Architect and at locations designated by Architect, take one core sample per 1000 sq. ft. of resinous coating, or portion of, to verify thickness. For each sample that fails to comply with requirements, take two additional samples. Repair damage caused by coring and correct deficiencies.
- B. Material Sampling: Architect may at any time and any number of times during resinous coating application require material samples for testing for compliance with requirements.
 - 1. Owner will engage an independent testing agency to take samples of materials being used. Material samples will be taken, identified, sealed, and certified in presence of Contractor.
 - 2. Testing agency will test samples for compliance with requirements, using applicable referenced testing procedures or, if not referenced, using testing procedures listed in manufacturer's product data.
 - 3. If test results show applied materials do not comply with specified requirements, pay for testing, remove noncomplying materials, prepare surfaces coated with unacceptable materials, and reapply coating materials to comply with requirements.

3.04 PROTECTION

- A. Protect resinous coating from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by resinous coating manufacturer.

END OF SECTION 09 67 23

SECTION 09 68 13**TILE CARPETING****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. This Section includes carpet tile, accessory materials and installation.
- B. Related Sections include the following:
 - 1. Division 01 Section "Concrete Moisture Vapor Emission Testing" for testing materials and procedures for carpet tiles with rubber or unitary type backing adhered to concrete floor.
 - 2. Division 09 Section "Resilient Wall Base and Accessories" for resilient wall base and accessories installed with carpet.

1.03 SUBMITTALS

- A. Product Data: For each type of product indicated. Include manufacturer's written data on physical characteristics, durability, and fade resistance. Include installation methods. Include percentage of recycled content.
- B. LEED Submittals:
 - 1. Credit MR 4.1 and 4.2: Manufacturer's product data indicating percentage of recycled content.
 - 2. Credit EQ 4.1: Manufacturers' product data for adhesives and sealants, including printed statement of VOC content.
 - 3. Credit EQ 4.3: Manufacturer's product data indicating VOC content of carpet and backing.
- C. Shop Drawings: Show the following:
 - 1. Columns, doorways, enclosing walls or partitions, built-in cabinets, and locations where cutouts are required in carpet tiles.
 - 2. Existing flooring materials to be removed.
 - 3. Existing flooring materials to remain.
 - 4. Carpet tile type, color, and dye lot.
 - 5. Type of subfloor.
 - 6. Type of installation.
 - 7. Pattern of installation.
 - 8. Pattern type, location, and direction.
 - 9. Pile direction.
 - 10. Type, color, and location of insets and borders.
 - 11. Type, color, and location of edge, transition, and other accessory strips.
 - 12. Transition details to other flooring materials.

- D. Samples: For each of the following products and for each color and texture required. Label each Sample with manufacturer's name, material description, color, pattern, and designation indicated on Drawings and in schedules.
1. Carpet Tile: Full-size Sample.
 2. Exposed Edge Stripping and Accessory: 12-inch- long Samples.
- E. Product Schedule: Use same room and product designations indicated on Drawings and in schedules.
- F. Maintenance Data: For carpet tile to include in maintenance manuals specified in Division 1. Include the following:
1. Methods for maintaining carpet tile, including cleaning and stain-removal products and procedures and manufacturer's recommended maintenance schedule.
 2. Precautions for cleaning materials and methods that could be detrimental to carpet tile.

1.04 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who is certified by the Floor Covering Installation Board or who can demonstrate compliance with its certification program requirements.
- B. Fire-Test-Response Characteristics: Provide products with the critical radiant flux classification indicated in Part 2, as determined by testing identical products per ASTM E 648 by an independent testing and inspecting agency acceptable to authorities having jurisdiction.
- C. Product Options: Products and manufacturers named in Part 2 establish requirements for product quality in terms of appearance, construction, and performance. Other manufacturers' products comparable in quality to named products and complying with requirements may be considered. Refer to Division 1 Section "Substitutions."

1.05 DELIVERY, STORAGE, AND HANDLING

- A. General: Comply with CRI 104, Section 5, "Storage and Handling."

1.06 PROJECT CONDITIONS

- A. General: Comply with CRI 104, Section 6.1, "Site Conditions; Temperature and Humidity."
- B. Environmental Limitations: Do not install carpet tile until wet work in spaces is complete and dry, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
- C. Do not install carpet tile over concrete slabs until slabs have cured and are sufficiently dry to bond with adhesive and concrete slabs have pH range recommended by carpet tile manufacturer.

- D. Where demountable partitions or other items are indicated for installation on top of carpet tile, install carpet tile before installing these items.
- E. Subfloor Moisture Conditions for carpet tiles with rubber or unitary type backing adhered to floor.: Moisture emission rate of not more than 3 lb/1000 sq. ft./24 hours when tested in accordance with Division 9 Section "Concrete Moisture Vapor Emission Testing."

1.07 WARRANTY

- A. General Warranty: Special warranty specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.
- B. Special Carpet Tile Warranty: Written warranty, signed by carpet tile manufacturer agreeing to replace carpet tile that does not comply with requirements or that fails within specified warranty period. Warranty does not include deterioration or failure of carpet tile due to unusual traffic, failure of substrate, vandalism, or abuse. Failures include, but are not limited to, more than 10 percent loss of face fiber, edge raveling, snags, runs, and delamination.
 - 1. Warranty Period: 10 years from date of Substantial Completion.

1.08 EXTRA MATERIALS

- A. Furnish extra materials described below, before installation begins, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Carpet Tile: Full-size units equal to 5 percent of amount installed for each type indicated, but not less than 10 sq. yd..

PART 2 - PRODUCTS

2.01 CARPET TILE

- A. Basis of Design Products: Subject to compliance with requirements, provide Analogue by Lees or comparable products matching colors, patterns, weave, textures and density by another manufacturer.
 - 1. Recycled Content: Provide products with not less than 35 percent recycled content.
 - 2. VOC Content: Provide modular carpet products meeting or exceeding CRI Green Label Plus certification.
 - 3. Primary Backing/Backcoating: Manufacturer's standard PVC-free Underscore ES Cushion backing with TractionBack.
- B. Performance Characteristics: As follows:
 - 1. Critical Radiant Flux Classification: Not less than 0.45 W/sq. cm.
 - 2. Dry Breaking Strength: Not less than 100 lbf per ASTM D 2646.
 - 3. Colorfastness to Crocking: Not less than 4, wet and dry, per AATCC-165.

4. Colorfastness to Light: Not less than 4 after 40 AFU (AATCC fading units) per AATCC-16.
5. Antimicrobial Activity: Not less than 2-mm halo of inhibition for gram-positive bacteria; not less than 1-mm halo of inhibition for gram-negative bacteria; no fungal growth; per AATCC-174.

2.02 INSTALLATION ACCESSORIES

- A. Trowelable Leveling and Patching Compounds: Latex-modified, hydraulic-cement-based formulation provided by or recommended by carpet tile manufacturer.
- B. Adhesives: Water-resistant, mildew-resistant, nonstaining type to suit products and subfloor conditions indicated, that complies with flammability requirements for installed carpet tile and that is recommended by carpet tile manufacturer.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions for compliance with requirements for maximum moisture content, alkalinity range, installation tolerances, and other conditions affecting carpet tile performance. Verify that substrates and conditions are satisfactory for carpet tile installation and comply with requirements specified.
- B. Concrete Subfloors: Verify that concrete slabs comply with ASTM F 710 and the following:
 1. Slab substrates are dry and free of curing compounds, sealers, hardeners, and other materials that may interfere with adhesive bond.
 - a. Determine adhesion characteristics by performing bond tests recommended by carpet manufacturer.
 - b. Determine dryness and pH characteristics by performing moisture and pH tests specified in Division 9 Section "Concrete Moisture Vapor Transmission and pH Testing" and as recommended by carpet manufacturer.
 2. Subfloor finishes comply with requirements specified in Division 3 Section "Cast-in-Place Concrete" for slabs receiving carpet.
 3. Subfloors are free of cracks, ridges, depressions, scale, and foreign deposits.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. General: Comply with CRI 104, Section 6.2, "Site Conditions; Floor Preparation," and carpet tile manufacturer's written installation instructions for preparing substrates indicated to receive carpet tile installation.
- B. Use trowelable leveling and patching compounds, according to manufacturer's written instructions, to fill cracks, holes, and depressions in substrates.

- C. Remove coatings, including curing compounds, and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, without using solvents. Use mechanical methods recommended in writing by carpet tile manufacturer.
- D. Broom and vacuum clean substrates to be covered immediately before installing carpet tile. After cleaning, examine substrates for moisture, alkaline salts, carbonation, or dust. Proceed with installation only after unsatisfactory conditions have been corrected.

3.03 INSTALLATION

- A. General: Comply with CRI 104, Section 13, "Carpet Modules (Tiles)."
- B. Installation Method:
 - 1. On Concrete: As recommended in writing by carpet tile manufacturer.
- C. Cut and fit carpet tile to butt tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosings. Bind or seal cut edges as recommended by carpet tile manufacturer.
- D. Extend carpet tile into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.
- E. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on finish flooring as marked on subfloor. Use nonpermanent, nonstaining marking device.
- F. Install pattern parallel to walls and borders.

3.04 CLEANING AND PROTECTION

- A. Perform the following operations immediately after installing carpet tile:
 - 1. Remove excess adhesive, seam sealer, and other surface blemishes using cleaner recommended by carpet tile manufacturer.
 - 2. Remove yarns that protrude from carpet tile surface.
 - 3. Vacuum carpet tile using commercial machine with face-beater element.
- B. Protect installed carpet tile to comply with CRI 104, Section 15, "Protection of Indoor Installations."
- C. Protect carpet tile against damage from construction operations and placement of equipment and fixtures during the remainder of construction period. Use protection methods indicated or recommended in writing by carpet tile manufacturer.

END OF SECTION 09 68 13

SECTION 09 91 13.10
EXTERIOR PAINTING**PART 1 - GENERAL****1.1 SUMMARY**

- A. Furnish all labor, materials, tools, equipment, and services for Exterior Painting, as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

- A. Definitions:
 - 1. "Paint" and "painting" refer to applied coatings.
 - 2. Mechanical work and equipment: Work included in Mechanical Specification Divisions.
 - 3. Electrical work and equipment: Work included in Electrical Specification Divisions.
- B. Work included:
 - 1. Exterior surfaces scheduled to be painted, unless indicated to be painted under other sections.
 - 2. Except for colored, split-face, patterned, ground-face, glazed, and other concrete masonry units with integral architectural finish; paint exposed exterior and on-site concrete masonry unit surfaces, including areaway walls, backside faces of parapets, screen walls, and retaining walls.
 - 3. Mechanical and electrical work:
 - a. Exterior equipment and items not completely factory finished.
- C. Powder coatings to conform to:
 - 1. American Architectural Manufacturers Association (AAMA) 2605
 - a. Color retention: 10 years: Fade = Delta E
 - b. Chalk Resistance: 10 years: Chalk = 8
 - c. Gloss Retention: 10 years: 10% Loss
 - d. Dry Film Thickness: 1.2 mils minimum
 - e. Pretreatment System: Chrome or Chrome Free
 - f. Salt Spray: 4,000 hours
 - g. Humidity: 4,000 hours
 - 2. ASTM D3451-06

1.3 SUBMITTALS

- A. Product Data:
 - 1. Manufacturer's data for each paint type to be applied indicating conformance to specifications.
- A. Samples:
 - 1. Three 216mm X 280mm 8 1/2 IN x 11 IN samples of each color and finish as noted in Drawing I-001 Interior Notes & Finish Legend.
 - 2. Gloss samples.
- B. Contract Closeout Information:
 - 1. Maintenance data.

PART 2 - PRODUCTS**2.1 ACCEPTABLE MANUFACTURERS**

- A. Provide paint as product of one manufacturer as far as possible.
- B. Powder Coating:
 - 1. Base:
 - a. Linetec
 - 2. Optional:
 - a. DuPont
 - b. PPG
- C. Paints:
 - 1. Base:
 - a. Sherwin-Williams.
 - 2. Optional:
 - a. Benjamin Moore.
 - b. Glidden Professional.
 - c. PPG Architectural Finishes.
 - d. Pratt & Lambert.
 - e. Tnemec.
- D. Other manufacturers desiring approval comply with Section 00 26 00.

2.2 MATERIALS

- 1. Gloss range: MPI Standards as measured in accordance with ASTM D523:
 - a. Gloss Level 1 (Flat): Maximum 5 at 60 degrees, maximum 10 at 85 degrees.
 - b. Gloss Level 2 (Velvet): Maximum 10 at 60 degrees, 10-35 at 85 degrees.
 - c. Gloss Level 3 (Eggshell): 10-25 at 60 degrees, 10-35 at 85 degrees.
 - d. Gloss Level 4 (Satin): 20-35 at 60 degrees, minimum 35 at 85 degrees.
 - e. Gloss Level 5 (Semi-gloss): 35-70 at 60 degrees.
 - f. Gloss Level 6 (Gloss): 70-85 at 60 degrees.
 - g. Gloss Level 7 (High gloss): More than 85 at 60 degrees.
- 2. If the gloss range is not indicated, provide top coat with a MPI Gloss Level 3 (Eggshell) finish.
- 3. Submit gloss samples for approval prior to use.
- 4. Add flatteners if necessary to achieve specified gloss.
- 5. Part 3 includes a listing of surfaces and type of paint to be applied.

PART 3 - EXECUTION**3.1 INSPECTION**

- A. Examine surfaces carefully for defects which cannot be corrected and might prevent satisfactory results.
- B. Commencing of work in a specific area constitutes acceptance of surfaces, and responsibility for performance.

3.2 SURFACES NOT TO BE PAINTED

- A. Anodized aluminum, stainless steel, chromium plate, glass, copper, bronze or similar materials.
- B. Moving parts of valves, operating units, mechanical and electrical parts, such as valve and damper operators, sending devices, motor and fan shafts.
- C. Code labels, such as UL, FM that are mylar or flat (non-embossed) plates.

1. Embossed plates and labels stamped into frames will be painted, label and information on label to be readily visible and convenient for identification by authority having jurisdiction.
- D. Equipment identification or rating plates.
 - E. Items having complete factory finish with exception of:
 1. Exterior mechanical equipment.
 2. Exterior electrical equipment.

3.3 PREPARATION - GENERAL

- A. Assure that surfaces are clean and dry.
- B. Assure that surfaces are free of foreign materials which will affect adhesion or appearance.
- C. Remove mildew and neutralize surface.
- D. Eliminate efflorescence before painting.
- E. Before painting, test surfaces with moisture meter.
- F. Paint when moisture is within paint manufacturer's acceptable limits.

3.4 PREPARATION - EXISTING SURFACES

- A. Wherever existing work is cut, patched, or added to; touch up to match new work as closely as possible.
 1. Check compatibility of new coating to previously painted surfaces by applying test patch. Allow to dry and test adhesion before continuing painting work.
- B. Put existing work scheduled for repainting in condition to provide good adhesion and to receive paint.
 1. Wash thoroughly surfaces to be repainted with abrasive kitchen cleaner or sand to manufacturer's recommendations.
 2. Remove residue from cleaning and abrading procedures.
 3. Spot prime bare areas.
- C. Where a wall or ceiling is disturbed and patched, repaint entire wall or ceiling.
- D. On surfaces to be refinished remove hardware, accessories, plates, surface mounted lighting fixtures, and similar items not to be coated, or provide protection during preparation and coating operations.
- E. Protect (and do not paint) code labels, such as UL, FM that are mylar or flat (non-embossed) plates.
 1. Embossed plates and labels stamped into frames may be painted, label and information on label to be readily visible and convenient for identification by authority having jurisdiction.

3.5 MATERIAL PREPARATION

- A. Mix and prepare materials per manufacturer's specifications.
- B. Stir, agitate or blend materials to produce a mixture of uniform density as required for application of materials.

3.6 PREPARATION - GALVANIZED METAL SURFACES AND NON-ANODIZED ALUMINUM

- A. Follow requirements of SSPC SP1.
- B. Treat surfaces with galvanized surface cleaner as recommended by primer and topcoat manufacturer.

-
- C. Non-anodized aluminum to receive a powder coating shall be clean and free of oils, soils, greases, welding scales, etc. to achieve a smooth and untarnished surface.

3.7 PREPARATION – CONCRETE AND MASONRY

- A. Repair minor defects.
- B. Remove oil from concrete by washing with xylol.
- C. Block Filler:
 - 1. Apply masonry to fill pinholes and minor surface defects, and to prime surface for topcoat.
 - 2. Apply by brush, roller or sprayer.
 - a. Where spray-applied: Back-roll with roller or squeegee.
 - 3. Minimum Nominal Thickness: 10 mil DFT.
 - a. Comply with manufacturer's recommended coverage rates for conditions encountered.
 - 4. Provide complete cover with recommended coating system.
- D. Obtain architect's approval of finish for surfaces to receive high build glazed coatings.

3.8 APPLICATION - GENERAL

- A. Paint surfaces as indicated in the drawings.
- B. Provide complete coverage and hide.
 - 1. Paint systems are to cover.
 - 2. When color or undercoats show through, apply additional coats at no additional cost until paint film is of uniform finish and color.
- C. Employ only skilled mechanics.
- D. Mix and apply as recommended by manufacturer.
- E. Install when temperature, humidity, and surface conditions are acceptable to manufacturer.
- F. If Architect so directs, do not apply succeeding coats until Architect has an opportunity to observe previous coat.
- G. Remove and protect hardware, accessories, plates, fixtures, finished work, and similar items; or provide ample in-place protection.
- H. Upon completion of painting, carefully replace removed items and/or remove protection.
- I. Apply materials under adequate illumination.
- J. Evenly spread and smoothly flow on for full, smooth cover.
- K. Assure that coats are dry before recoating.
- L. Touch up suction or hot spots in plaster, concrete block, and concrete before painting.
- M. Touch up abraded areas of shop prime coats before subsequent coats are applied.
- N. Back prime wood trim with penetrating sealer.
- O. Finish colors not indicated shall be selected by Architect from paint manufacturer's standard colors.

3.9 PROTECTION AND CLEANUP

- A. Protect adjacent work against damage by painting and finishing work.
- B. Clean, repair or replace, and repaint damaged work as directed by Architect.
- C. Provide "WET PAINT" signs.

-
- D. Remove temporary protective wrappings, after completion of operations.
 - E. Clean paint spattered surfaces.
 - F. Use care not to damage finished surfaces.
 - G. Remove surplus materials, scaffolding and debris.
 - H. Leave areas broom clean.

3.10 SCHEDULE - EXTERIOR PAINT SYSTEMS

- A. Non-Anodized Aluminum:
 - 1. Powder coating, smooth
 - a. Application shall conform to the manufacturer's instructions.
- B. Concrete:
 - 1. Elastomeric, smooth:
 - a. Sherwin Williams:
 - 1) Primer coat: Recommended by topcoat manufacturer for each substrate.
 - 2) Intermediate coat: ConFlex XL Elastomeric High Build Smooth; A5-400.
 - 3) Topcoat: ConFlex XL Elastomeric High Build Smooth; A5-400.
 - b. Glidden Professional:
 - 1) Primer coat: Recommended by topcoat manufacturer for each substrate.
 - 2) Intermediate coat: Decra-Flex 300 Elastomeric Coating; 2260.
 - 3) Topcoat: Exterior: Decra-Flex 300 Elastomeric Coating; 2260.
 - c. PPG:
 - 1) Primer coat: Recommended by topcoat manufacturer for each substrate.
 - 2) Intermediate coat: Pitt Flex Elastomeric: 4-110.
 - 3) Topcoat: Pitt Flex Elastomeric: 4-110.
 - C. Concrete block:
 - 1. Elastomeric, smooth:
 - a. Sherwin Williams:
 - 1) Primer coat: Recommended by topcoat manufacturer for each substrate.
 - 2) Intermediate coat: ConFlex XL Elastomeric High Build Smooth; A5-400.
 - 3) Topcoat: ConFlex XL Elastomeric High Build Smooth; A5-400.
 - b. Glidden Professional:
 - 1) Primer coat: Recommended by topcoat manufacturer for each substrate.
 - 2) Intermediate coat: Decra-Flex 300 Elastomeric Coating; 2260.
 - 3) Topcoat: Exterior: Decra-Flex 300 Elastomeric Coating; 2260.
 - c. PPG:
 - 1) Primer coat: Recommended by topcoat manufacturer for each substrate.
 - 2) Intermediate coat: Pitt Flex Elastomeric; 4-110.
 - 3) Topcoat: Pitt Flex Elastomeric; 4-110.
 - D. Structural steel (exposed):
 - 1. Water based urethane, Gloss Level 3 (Egg Shell):
 - a. Sherwin Williams:
 - 1) Primer coat: Recommended by topcoat manufacturer for each substrate.
 - 2) Intermediate coat: Acrolon 100 Water Based Urethane Gloss, B65-720.
 - 3) Topcoat: Acrolon 100 Water Based Urethane Gloss, B65-720.
 - a) Clear coat: Diamond-Clad Clear Coat Urethane, B65 Series.
 - b. Glidden Professional:
 - 1) Primer coat: Recommended by topcoat manufacturer for each substrate.
 - 2) Intermediate coat: Devthane UVA Aliphatic Urethane Gloss Enamel; 389.
 - 3) Topcoat: Devthane UVA Aliphatic Urethane Gloss Enamel; 389.
 - 4) Clear coat: Manufacturer recommended.
 - c. PPG:
 - 1) Primer coat: Recommended by topcoat manufacturer for each substrate.

-
- 2) Intermediate coat: Pitthane Ultra Gloss Urethane 95-812.
 - 3) Topcoat: Pitthane Ultra Gloss Urethane 95-812.
 - 4) Clear coat: Pitthane Ultra Gloss Urethane 95-812.
 - d. Tnemec:
 - 1) Primer coat: Recommended by topcoat manufacturer for each substrate.
 - 2) Second coat: Epoxy polyamide, Tnemec Series 66 High Build Epoxoline.
 - 3) Third coat: Aliphatic polyurethane, Tnemec Series 74 Endura-Shield.

PART 4 - MEASUREMENT

4.1 Measurement – No Separate measurement will be made for Work described in this Section.

PART 5 - PAYMENT

5.1 Payment – Payment for items in this Section will be incidental to the Contract lump sum cost of the Station Stops.

END OF SECTION

SECTION 09 91 13**EXTERIOR PAINTING****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. This Section includes surface preparation and the application of paint systems on the following exterior substrates and interior substrates exposed to humid conditions:
 - 1. Concrete.
 - 2. Galvanized metal.
 - 3. Architecturally exposed structural steel, interior and exterior locations.
- B. Related Sections include the following:
 - 1. Division 5 Sections for shop priming of metal substrates with primers specified in this Section.
 - 2. Division 9 Section "Interior Painting" for surface preparation and the application of paint systems on interior substrates.

1.03 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples for Verification: For each type of paint system and each color and gloss of topcoat indicated.
 - 1. Submit Samples on rigid backing, 8 inches square.
 - 2. Step coats on Samples to show each coat required for system.
 - 3. Label each coat of each Sample.
 - 4. Label each Sample for location and application area.
- C. Product List: For each product indicated, include the following:
 - 1. Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules.
 - 2. Printout of current "MPI Approved Products List" for each product category specified in Part 2, with the proposed product highlighted.

1.04 QUALITY ASSURANCE

- A. MPI Standards:
 - 1. Products: Complying with MPI standards indicated and listed in "MPI Approved Products List."
 - 2. Preparation and Workmanship: Comply with requirements in "MPI Architectural Painting Specification Manual" for products and paint systems indicated.

- B. Mockups: Apply benchmark samples of each paint system indicated and each color and finish selected to verify preliminary selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
 - 1. Architect will select one surface to represent surfaces and conditions for application of each paint system specified in Part 3.
 - a. Vertical and Horizontal Surfaces: Provide samples of at least 100 sq. ft..
 - b. Other Items: Architect will designate items or areas required.
 - 2. Final approval of color selections will be based on benchmark samples.
 - a. If preliminary color selections are not approved, apply additional benchmark samples of additional colors selected by Architect at no added cost to Owner.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.
 - 1. Maintain containers in clean condition, free of foreign materials and residue.
 - 2. Remove rags and waste from storage areas daily.

1.06 PROJECT CONDITIONS

- A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F.
- B. Do not apply paints in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.

1.07 EXTRA MATERIALS

- A. Furnish extra materials described below that are from same production run (batch mix) as materials applied and that are packaged for storage and identified with labels describing contents.
 - 1. Quantity: Furnish an additional 5 percent, but not less than 1 gal. of each material and color applied.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Benjamin Moore & Co.
 - 2. California Paints.
 - 3. ChemRex.
 - 4. Cloverdale Paint.
 - 5. Color Wheel Paints & Coatings.
 - 6. Columbia Paint & Coatings.
 - 7. Diamond Vogel Paints.

8. Dunn-Edwards Corporation.
9. Durant Paints Inc.
10. ICI Paints.
11. Kelly-Moore Paints.
12. Kwal-Howells Paint.
13. PPG Architectural Finishes, Inc.
14. Sherwin-Williams Company (The).

2.02 PAINT, GENERAL

A. Material Compatibility:

1. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
2. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.

B. Colors: As indicated in a color schedule on Drawings.

2.03 BLOCK FILLERS

- A. Interior/Exterior Latex Block Filler: MPI #4.
- B. Epoxy Block Filler: MPI #116

2.04 PRIMERS/SEALERS

- A. Alkali-Resistant Primer: MPI #3.

2.05 METAL PRIMERS

- A. Waterborne Galvanized-Metal Primer: MPI #134.
- B. Epoxy Zinc Rich Primer: MPI #20.

2.06 EXTERIOR LATEX PAINTS

- A. Exterior Latex (Semigloss): MPI #11 (Gloss Level 5).
- B. Exterior Latex (Gloss): MPI #119 (Gloss Level 6, except minimum gloss of 65 units at 60 deg).

2.07 POLYURETHANE COATINGS

- A. Polyurethane, Two-Component, Pigmented, Gloss: MPI #72.

2.08 EXTERIOR ALKYD PAINTS

- A. Exterior Alkyd Enamel (Semigloss): MPI #94 (Gloss Level 5).
- B. Exterior Alkyd Enamel (Gloss): MPI #9 (Gloss Level 6).

2.09 QUICK-DRYING ENAMELS

- A. Quick-Drying Enamel (Semigloss): MPI #81 (Gloss Level 5).
- B. Quick-Drying Enamel (High Gloss): MPI #96 (Gloss Level 7).

2.10 TEXTURED AND HIGH-BUILD COATINGS

- A. Latex Stucco and Masonry Textured Coating: MPI #42.

2.11 EPOXY COATINGS

- A. Epoxy, Cold-Cured, Gloss: MPI #77.
- B. Epoxy, High-Build, Low Gloss: MPI #108.

2.12 LIGHT INDUSTRIAL COATINGS

- A. Exterior Light Industrial Coating, Water-Based: MPI #163

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of work.
- B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
 - 1. Concrete: 12 percent.
 - 2. Gypsum Board: 12 percent.
- C. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.
- D. Begin coating application only after unsatisfactory conditions have been corrected and surfaces are dry.
 - 1. Beginning coating application constitutes Contractor's acceptance of substrates and conditions.

3.02 PREPARATION

- A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates and paint systems indicated.
- B. Remove plates, machined surfaces, and similar items already in place that are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
 - 1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.
 - 2. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
- C. Clean substrates of substances that could impair bond of paints, including dirt, oil, grease, and incompatible paints and encapsulants.
 - 1. Remove incompatible primers and reprime substrate with compatible primers as

required to produce paint systems indicated.

- D. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.
- E. Steel Substrates: Remove rust and loose mill scale. Clean using methods recommended in writing by paint manufacturer.
 - 1. For Architecturally Exposed Structural Steel, clean with a method not less than SSPC-SP6
- F. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal fabricated from coil stock by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.
- G. Exterior Gypsum Board Substrates: Do not begin paint application until finishing compound is dry and sanded smooth.

3.03 APPLICATION

- A. Apply paints according to manufacturer's written instructions.
 - 1. Use applicators and techniques suited for paint and substrate indicated.
 - 2. Paint surfaces behind movable items same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed items with prime coat only.
- B. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Tint undercoats to match color of topcoat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.
- C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.
- D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

3.04 FIELD QUALITY CONTROL

- A. Testing of Paint Materials: Owner reserves the right to invoke the following procedure at any time and as often as Owner deems necessary during the period when paints are being applied:
 - 1. Owner will engage the services of a qualified testing agency to sample paint materials being used. Samples of material delivered to Project site will be taken, identified, sealed, and certified in presence of Contractor.
 - 2. Testing agency will perform tests for compliance of paint materials with product requirements.
 - 3. Owner may direct Contractor to stop applying paints if test results show materials being used do not comply with product requirements. Contractor shall remove noncomplying-paint materials from Project site, pay for testing, and repaint surfaces painted with rejected materials. Contractor will be required to remove rejected materials from previously painted surfaces if, on repainting with complying materials, the two paints are incompatible.

3.05 CLEANING AND PROTECTION

- A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
- B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
- C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.
- D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.06 EXTERIOR PAINTING SCHEDULE

- A. Concrete Substrates, Nontraffic Surfaces:
 - 1. Latex System: MPI EXT 3.1A.
 - a. Prime Coat: Exterior latex matching topcoat.
 - b. Intermediate Coat: Exterior latex matching topcoat.
 - c. Topcoat: Exterior latex, gloss level as selected by Architect.
- B. Concrete Substrates, Traffic Surfaces:
 - 1. Clear Sealer System: MPI EXT 3.2G.
 - a. Prime Coat: Interior/exterior clear concrete floor sealer (solvent based).
 - b. Intermediate Coat: Interior/exterior clear concrete floor sealer (solvent based).
 - c. Topcoat: Interior/exterior clear concrete floor sealer (solvent based).
 - 2. Water-Based Clear Sealer System: MPI EXT 3.2H.
 - a. Prime Coat: Interior/exterior clear concrete floor sealer (water based).
 - b. Intermediate Coat: Interior/exterior clear concrete floor sealer (water based).
 - c. Topcoat: Interior/exterior clear concrete floor sealer (water based).
- C. Steel Substrates, other than Architecturally Exposed Structural Steel:
 - 1. Polyurethane, Pigmented Coating System: MPI EXT 5.1P
 - a. Prime Coat: Epoxy Zinc Rich Primer: MPI #20.
 - b. Intermediate Coat: Epoxy primer, MPI #77.
 - c. Topcoat: Polyurethane, two-component, pigmented, gloss, MPI #72.

D. Architecturally Exposed Structural Steel, Interior and Exterior:

1. Pigmented Polyurethane over Epoxy Zinc-Rich Primer and High-Build Epoxy System: MPI EXT 5.1G
 - d. Prime Coat: Primer, zinc-rich, epoxy, MPI #20.
 - e. Intermediate Coat: Epoxy, high-build, low gloss, MPI #108.
 - f. Topcoat: Polyurethane, two-component, pigmented, gloss (Gloss Level 6), MPI #72.

E. Galvanized-Metal Substrates:

1. Light Industrial Coating System: MPI EXT 5.3J]
 - a. Prime Coat: Water-borne primer, MPI #134
 - b. Intermediate Coat: Water-borne light Industrial coating, MPI #163
 - c. Topcoat: Water-borne light industrial coating, semi-gloss, MPI #163

END OF SECTION 09 91 13

SECTION 09 91 23**INTERIOR PAINTING****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. This Section includes surface preparation and the application of paint systems on the following interior substrates:
1. Concrete masonry units (CMU).
 2. Steel.
 3. Galvanized metal.
 4. Aluminum (not anodized or otherwise coated).
 5. Gypsum board.
- B. Related Sections include the following:
1. Division 01 Section "Sustainable Design Requirements" for additional LEED requirements.
 2. Division 05 Sections for shop priming of metal substrates with primers specified in this Section.
 3. Division 06 Sections for shop priming carpentry with primers specified in this Section.
 4. Division 08 Sections for factory priming windows and doors with primers specified in this Section.
 5. Division 09 Section "Exterior Painting" for surface preparation and the application of paint systems on exterior substrates.

1.03 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples for Initial Selection: For each type of topcoat product indicated.
- C. Samples for Verification: For each type of paint system and in each color and gloss of topcoat indicated.
1. Submit Samples on rigid backing, 8 inches square.
 2. Step coats on Samples to show each coat required for system.
 3. Label each coat of each Sample.
 4. Label each Sample for location and application area.
- D. Product List: For each product indicated, include the following:
1. Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules.
 2. Printout of current "MPI Approved Products List" for each product category specified in Part 2, with the proposed product highlighted.

- E. LEED Submittals: For Credit EQ 4.2, manufacturers' product data for paints, including printed statement of VOC content and chemical components.

1.04 QUALITY ASSURANCE

A. MPI Standards:

1. Products: Complying with MPI standards indicated and listed in "MPI Approved Products List."
2. Preparation and Workmanship: Comply with requirements in "MPI Architectural Painting Specification Manual" for products and paint systems indicated.

B. Mockups: Apply benchmark samples of each paint system indicated and each color and finish selected to verify preliminary selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Architect will select one surface to represent surfaces and conditions for application of each paint system specified in Part 3.
 - a. Wall and Ceiling Surfaces: Provide samples of at least 100 sq. ft..
 - b. Other Items: Architect will designate items or areas required.
2. Apply benchmark samples after permanent lighting and other environmental services have been activated.
3. Final approval of color selections will be based on benchmark samples.
 - a. If preliminary color selections are not approved, apply additional benchmark samples of additional colors selected by Architect at no added cost to Owner.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.
1. Maintain containers in clean condition, free of foreign materials and residue.
 2. Remove rags and waste from storage areas daily.

1.06 PROJECT CONDITIONS

- A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F.
- B. Do not apply paints when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.

1.07 EXTRA MATERIALS

- A. Furnish extra materials described below that are from same production run (batch mix) as materials applied and that are packaged for storage and identified with labels describing contents.
1. Quantity: Furnish an additional 5 percent, but not less than 1 gal. of each material and color applied.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Benjamin Moore & Co.
 2. Cloverdale Paint.
 3. Color Wheel Paints & Coatings.
 4. Columbia Paint & Coatings.
 5. Diamond Vogel Paints.
 6. Dunn-Edwards Corporation.
 7. Durant Paints Inc.
 8. ICI Paints.
 9. Kelly-Moore Paints.
 10. Kwal-Howells Paint.
 11. PPG Architectural Finishes, Inc.
 12. Sherwin-Williams Company (The).

2.02 PAINT, GENERAL

- A. Material Compatibility:
1. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
 2. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.
- B. Chemical Components of Field-Applied Interior Paints and Coatings: Provide products that comply with the following limits for VOC content, exclusive of colorants added to a tint base, when calculated according to 40 CFR 59, Subpart D (EPA Method 24) and the following chemical restrictions; these requirements do not apply to primers or finishes that are applied in a fabrication or finishing shop:
1. Flat Paints and Coatings: VOC content of not more than 50 g/L.
 2. Nonflat Paints and Coatings: VOC content of not more than 150 g/L.
 3. Aromatic Compounds: Paints and coatings shall not contain more than 1.0 percent by weight of total aromatic compounds (hydrocarbon compounds containing one or more benzene rings).
 4. Restricted Components: Paints and coatings shall not contain any of the following:
 - a. Acrolein.
 - b. Acrylonitrile.
 - c. Antimony.
 - d. Benzene.
 - e. Butyl benzyl phthalate.
 - f. Cadmium.
 - g. Di (2-ethylhexyl) phthalate.
 - h. Di-n-butyl phthalate.
 - i. Di-n-octyl phthalate.
 - j. 1,2-dichlorobenzene.
 - k. Diethyl phthalate.
 - l. Dimethyl phthalate.
 - m. Ethylbenzene.

- n. Formaldehyde.
- o. Hexavalent chromium.
- p. Isophorone.
- q. Lead.
- r. Mercury.
- s. Methyl ethyl ketone.
- t. Methyl isobutyl ketone.
- u. Methylene chloride.
- v. Naphthalene.
- w. Toluene (methylbenzene).
- x. 1,1,1-trichloroethane.
- y. Vinyl chloride.

C. Colors: As indicated in a color schedule on Drawings.

2.03 BLOCK FILLERS

- A. Interior/Exterior Latex Block Filler: MPI #4.
 - 1. VOC Content: E Range of E3.
- B. Block Filler, Epoxy: MPI #116.
 - 1. VOC Content: E Range of E3.

2.04 PRIMERS/SEALERS

- A. Interior Latex Primer/Sealer: MPI #50.
 - 1. VOC Content: E Range of E3.
- B. Interior Alkyd Primer/Sealer: MPI #45.
 - 1. VOC Content: E Range of E2.

2.05 METAL PRIMERS

- A. Alkyd Anticorrosive Metal Primer: MPI #79.
 - 1. VOC Content: E Range of E2.
- B. Epoxy Primer: MPI #101
 - 1. VOC Content: E Range of E1.
- C. Waterborne Galvanized-Metal Primer: MPI #134.
 - 1. VOC Content: E Range of E3
- D. Vinyl Wash Primer: MPI #80.
 - 1. VOC Content: E Range of E3.

2.06 INTERMEDIATE COATS

- A. High-build Epoxy: MPI #108
 - 1. VOC Content: E Range of E2.

2.07 LATEX PAINTS

- A. Interior Latex (Flat): MPI #53 (Gloss Level 1).
 - 1. VOC Content: E Range of E3.
- B. Interior Latex (Low Sheen): MPI #44 (Gloss Level 2).
 - 1. VOC Content: E Range of E3.
- C. Interior Latex (Eggshell): MPI #52 (Gloss Level 3).
 - 1. VOC Content: E Range of E3.
- D. Interior Latex (Satin): MPI #43 (Gloss Level 4).
 - 1. VOC Content: E Range of E3
- E. Interior Latex (Semigloss): MPI #54 (Gloss Level 5).
 - 1. VOC Content: E Range of E3
- F. Interior Latex (Gloss): MPI #114 (Gloss Level 6, except minimum gloss of 65 units at 60 deg).
 - 1. VOC Content: E Range of E31
- G. High-Performance Architectural Latex (Low Sheen): MPI #138 (Gloss Level 2).
 - 1. VOC Content: E Range of E3
- H. High-Performance Architectural Latex (Eggshell): MPI #139 (Gloss Level 3).
 - 1. VOC Content: E Range of E3
- I. High-Performance Architectural Latex (Satin): MPI #140 (Gloss Level 4).
 - 1. VOC Content: E Range of E3
- J. High-Performance Architectural Latex (Semigloss): MPI #141 (Gloss Level 5).
 - 1. VOC Content: E Range of E3
- K. Exterior Latex (Flat): MPI #10 (Gloss Level 1).
 - 1. VOC Content: E Range of E3
- L. Exterior Latex (Semigloss): MPI #11 (Gloss Level 5).
 - 1. VOC Content: E Range of E3.
- M. Exterior Latex (Gloss): MPI #119 (Gloss Level 6, except minimum gloss of 65 units at 60 deg).
 - 1. VOC Content: E Range of E3.

2.08 ALKYD PAINTS

- A. Interior Alkyd (Eggshell): MPI #51 (Gloss Level 3).
 - 1. VOC Content: E Range of E2.
- B. Interior Alkyd (Semigloss): MPI #47 (Gloss Level 5).
 - 1. VOC Content: E Range of E2.

2.09 EPOXY COATINGS

- A. Epoxy, Cold-Cured, Gloss: MPI #77.

2.10 POLYURETHANE COATINGS

- A. Pigmented Polyurethane: MPI #72
 - 1. VOC Content: E Range of E2.

2.11 DRY FOG/FALL COATINGS

- A. Latex Dry Fog/Fall: MPI #118.
 - 1. VOC Content: E Range of E3.
- B. Waterborne Dry Fall: MPI #133.
 - 1. VOC Content: E Range of E3.
- C. Interior Alkyd Dry Fog/Fall: MPI #55.
 - 1. VOC Content: E Range of E3.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of work.
- B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
 - 1. Concrete: 12 percent.
 - 2. Masonry (CMU): 12 percent.
 - 3. Wood: 15 percent.
 - 4. Gypsum Board: 12 percent.
- C. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.
- D. Begin coating application only after unsatisfactory conditions have been corrected and surfaces are dry.

1. Beginning coating application constitutes Contractor's acceptance of substrates and conditions.

3.02 PREPARATION

- A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates indicated.
- B. Remove plates, machined surfaces, and similar items already in place that are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
 1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.
 2. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
- C. Clean substrates of substances that could impair bond of paints, including dirt, oil, grease, and incompatible paints and encapsulants.
 1. Remove incompatible primers and reprime substrate with compatible primers as required to produce paint systems indicated.
- D. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.
- E. Concrete Masonry Substrates: Remove efflorescence and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.
- F. Steel Substrates: Remove rust and loose mill scale. Clean using SSPC-SP6 unless another method is recommended in writing by paint manufacturer.
- G. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal fabricated from coil stock by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.
- H. Aluminum Substrates: Remove surface oxidation.
- I. Gypsum Board Substrates: Do not begin paint application until finishing compound is dry and sanded smooth.
- J. Plaster Substrates: Do not begin paint application until plaster is fully cured and dry.
- K. Spray-Textured Ceiling Substrates: Do not begin paint application until surfaces are dry.
- L. Cotton or Canvas Insulation Covering Substrates: Remove dust, dirt, and other foreign material that might impair bond of paints to substrates.

3.03 APPLICATION

- A. Apply paints according to manufacturer's written instructions.
 1. Use applicators and techniques suited for paint and substrate indicated.

2. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
 3. Paint front and backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
- B. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Tint undercoats to match color of topcoat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.
- C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.
- D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.
- E. Painting Mechanical and Electrical Work: Paint items exposed in equipment rooms and occupied spaces including, but not limited to, the following:
1. Mechanical Work:
 - a. Uninsulated metal piping.
 - b. Uninsulated plastic piping.
 - c. Pipe hangers and supports.
 - d. Tanks that do not have factory-applied final finishes.
 - e. Visible portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets.
 - f. Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.
 - g. Mechanical equipment that is indicated to have a factory-primed finish for field painting.
 2. Electrical Work:
 - a. Switchgear.
 - b. Panelboards.
 - c. Electrical equipment that is indicated to have a factory-primed finish for field painting.

3.04 FIELD QUALITY CONTROL

- A. Testing of Paint Materials: Owner reserves the right to invoke the following procedure at any time and as often as Owner deems necessary during the period when paints are being applied:
1. Owner will engage the services of a qualified testing agency to sample paint materials being used. Samples of material delivered to Project site will be taken, identified, sealed, and certified in presence of Contractor.
 2. Testing agency will perform tests for compliance with product requirements.
 3. Owner may direct Contractor to stop applying paints if test results show materials being used do not comply with product requirements. Contractor shall remove noncomplying-paint materials from Project site, pay for testing, and repaint surfaces painted with rejected materials. Contractor will be required to remove rejected materials from previously painted surfaces if, on repainting with complying materials, the two paints are incompatible.

3.05 CLEANING AND PROTECTION

- A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
- B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
- C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.
- D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.06 INTERIOR PAINTING SCHEDULE

- A. Concrete Substrates, Nontraffic Surfaces ad Identified on Drawings:
 - 1. Latex System: MPI INT 3.1E.
 - a. Prime Coat: Interior latex matching topcoat.
 - b. Intermediate Coat: Interior latex matching topcoat.
 - c. Topcoat: Interior latex, gloss as selected by Architect.
 - 2. Latex Over Sealer System: MPI INT 3.1A.
 - a. Prime Coat: Interior latex primer/sealer.
 - b. Intermediate Coat: Interior latex matching topcoat.
 - c. Topcoat: Interior latex, gloss as selected by Architect.
 - 3. Latex Over Latex Aggregate System: MPI INT 3.1B.
 - a. Prime Coat: Latex stucco and masonry textured coating.
 - b. Intermediate Coat: Exterior latex matching topcoat.
 - c. Topcoat: Exterior latex, gloss as selected by Architect.
 - 4. Alkyd System: MPI INT 3.1D.
 - a. Prime Coat: Interior latex primer/sealer.
 - b. Intermediate Coat: Interior alkyd matching topcoat.
 - c. Topcoat: Interior alkyd, gloss as selected by Architect.
 - 5. High-Performance Architectural Latex System: MPI INT 3.1C.
 - a. Prime Coat: Interior latex primer/sealer.
 - b. Intermediate Coat: High-performance architectural latex matching topcoat.
 - c. Topcoat: High-performance architectural latex, gloss as selected by Architect.
 - 6. Vertical Concrete Surfaces in Wash Bay: MPI INT 3.1F
 - a. Prime Coat: Epoxy, Cold-Cured, Gloss: MPI #77
 - b. Topcoat: Epoxy, Cold-Cured, Gloss: MPI #77, 2 coats
- B. Concrete Substrates, Traffic Surfaces as Identified on Drawings:

1. Latex Floor Enamel System: MPI INT 3.2A.
 - a. Prime Coat: Interior/exterior latex floor and porch paint (low gloss).
 - b. Intermediate Coat: Interior/exterior latex floor and porch paint (low gloss).
 - c. Topcoat: Interior/exterior latex floor and porch paint (low gloss).
 2. Alkyd Floor Enamel System: MPI INT 3.2B.
 - a. Prime Coat: Exterior/interior alkyd floor enamel (gloss).
 - b. Intermediate Coat: Exterior/interior alkyd floor enamel (gloss).
 - c. Topcoat: Exterior/interior alkyd floor enamel (gloss).
 3. Concrete Stain System: MPI INT 3.2E.
 - a. First Coat: Interior concrete floor stain.
 - b. Topcoat: Interior concrete floor stain.
 4. Clear Sealer System: MPI INT 3.2F.
 - a. First Coat: Interior/exterior clear concrete floor sealer (solvent based).
 - b. Topcoat: Interior/exterior clear concrete floor sealer (solvent based).
 5. Water-Based Clear Sealer System: MPI INT 3.2G.
 - a. First Coat: Interior/exterior clear concrete floor sealer (water based).
 - b. Topcoat: Interior/exterior clear concrete floor sealer (water based).
- C. CMU Substrates:
1. Latex System: MPI INT 4.2A.
 - a. Prime Coat: Interior/exterior latex block filler.
 - b. Intermediate Coat: Interior latex matching topcoat.
 - c. Topcoat: Interior latex, gloss as selected by Architect.
 2. Alkyd System: MPI INT 4.2C.
 - a. Prime Coat: Interior/exterior latex block filler.
 - b. Intermediate Coat: Interior alkyd matching topcoat.
 - c. Topcoat: Interior alkyd, gloss as selected by Architect.
 3. Alkyd Over Latex Sealer System: MPI INT 4.2N.
 - a. Prime Coat: Interior/exterior latex block filler.
 - b. Sealer Coat: Interior latex primer/sealer.
 - c. Intermediate Coat: Interior alkyd matching topcoat.
 - d. Topcoat: Interior alkyd, gloss as selected by Architect.
 4. High-Performance Architectural Latex System: MPI INT 4.2D.
 - a. Prime Coat: Interior/exterior latex block filler.
 - b. Intermediate Coat: High-performance architectural latex matching topcoat.
 - c. Topcoat: High-performance architectural latex, gloss as selected by Architect.
 5. Epoxy Coatings (Tile-like) in Wash Bay: MPI INT 4.2G
 - a. Block Filler: Epoxy: MPI #116

-
- b. Topcoat: Epoxy, Cold-Cured, Gloss: MPI #77, 2 coats
- D. Steel Substrates other than Architecturally Exposed Structural Steel:
- 1. Latex Over Alkyd Primer System: MPI INT 5.1Q.
 - a. Prime Coat: Alkyd anticorrosive metal primer.
 - b. Intermediate Coat: Interior latex matching topcoat.
 - c. Topcoat: Interior latex , gloss as selected by Architect.
 - 2. Pigmented Polyurethane over High-Build Epoxy: MPI INT 5.1G
 - a. Prime Coat: Epoxy primer.
 - b. Intermediate Coat: High-build epoxy.
 - c. Topcoat: Polyurethane.
 - 3. Alkyd System: MPI INT 5.1E.
 - a. Prime Coat: Alkyd anticorrosive metal primer.
 - b. Intermediate Coat: Interior alkyd matching topcoat.
 - c. Topcoat: Interior alkyd, gloss as selected by Architect.
- E. Galvanized-Metal Substrates:
- 1. Latex System: MPI INT 5.3A.
 - a. Prime Coat: Cementitious galvanized-metal primer.
 - b. Intermediate Coat: Interior latex matching topcoat.
 - c. Topcoat: Interior latex, gloss as selected by Architect.
 - 2. Latex Over Waterborne Primer System: MPI INT 5.3J.
 - a. Prime Coat: Waterborne galvanized-metal primer.
 - b. Intermediate Coat: Interior latex matching topcoat.
 - c. Topcoat: Interior latex, gloss as selected by Architect.
 - 3. Aluminum Paint System: MPI INT 5.3G.
 - a. Prime Coat: Cementitious galvanized-metal primer.
 - b. Intermediate Coat: Aluminum paint.
 - c. Topcoat: Aluminum paint.
 - 4. High-Performance Architectural Latex System: MPI INT 5.3M.
 - a. Application: High-traffic areas such as hollow metal doors and door frames, hand rails, guard rails, and surfaces subject to humid environment.
 - b. Prime Coat: Waterborne galvanized-metal primer.
 - c. Intermediate Coat: High-performance architectural latex matching topcoat.
 - d. Topcoat: High-performance architectural latex, gloss as selected by Architect.
- F. Gypsum Board Substrates:
- 1. Latex System: MPI INT 9.2A.
 - a. Application: Office Storage Areas
 - b. Prime Coat: Interior latex matching topcoat.
 - c. Intermediate Coat: Interior latex matching topcoat.

- d. Topcoat: Interior latex, gloss as selected by Architect.
2. High-Performance Architectural Latex System: MPI INT 9.2B.
- a. Application: All interior gypsum board substrates except as noted otherwise.
 - b. Prime Coat: Interior latex primer/sealer.
 - c. Intermediate Coat: High-performance architectural latex matching topcoat.
 - d. Topcoat: High-performance architectural latex, gloss as selected by Architect.

END OF SECTION 09 91 23

SECTION 10 11 16**MARKERBOARDS****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section Includes:
 - 1. Markerboards.

1.03 DEFINITIONS

- A. Visual Display Board Assembly: Visual display surface that is factory fabricated into composite panel form, either with or without a perimeter frame; includes markerboards.
- B. Visual Display Surface: Surfaces that are used to convey information visually, including surfaces of markerboards and surfacing materials that are not fabricated into composite panel form but are applied directly to walls.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for visual display surfaces.
- B. LEED Submittals:
 - 1. Product Data for Credit IEQ 4.1: For adhesives, documentation including printed statement of VOC content.
 - 2. Product Data for Credit IEQ 4.4: For composite wood products, documentation indicating that the product contains no urea formaldehyde.
- C. Shop Drawings: For visual display surfaces. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Show locations of panel joints.
 - 2. Include sections of typical trim members.
- D. Samples for Initial Selection: For each type of visual display surface indicated, for units with factory-applied color finishes, and as follows:
 - 1. Actual sections of porcelain-enamel face sheet and display rail.
 - 2. Include accessory Samples to verify color selected.
- E. Samples for Verification: For each type of visual display surface indicated.
 - 1. Visual Display Surface: Not less than 8-1/2 by 11 inches , mounted on substrate indicated for final Work. Include one panel for each type, color, and texture required.

2. Trim: 6-inch- long sections of each trim profile.
3. Accessories: Full-size Sample of each type of accessory.

F. Product Schedule: For visual display surfaces. Use same designations indicated on Drawings.

1.05 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for surface-burning characteristics of fabrics.
- C. Warranties: Sample of special warranties.

1.06 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For visual display surfaces to include in maintenance manuals.

1.07 QUALITY ASSURANCE

- A. Source Limitations: Obtain visual display surfaces from single source from single manufacturer.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Deliver factory-built visual display surfaces, including factory-applied trim where indicated, completely assembled in one piece without joints, where possible. If dimensions exceed maximum manufactured panel size, provide two or more pieces of equal length as acceptable to Architect. When overall dimensions require delivery in separate units, prefit components at the factory, disassemble for delivery, and make final joints at the site.
- B. Store visual display surfaces vertically with packing materials between each unit.

1.09 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install visual display surfaces until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above ceilings is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.10 WARRANTY

- A. Special Warranty for Porcelain-Enamel Face Sheets: Manufacturer's standard form in which manufacturer agrees to repair or replace porcelain-enamel face sheets that fail in materials or workmanship within specified warranty period.
 1. Failures include, but are not limited to, the following:
 - a. Surfaces lose original writing and erasing qualities.
 - b. Surfaces exhibit crazing, cracking, or flaking.
 2. Warranty Period: Life of the building.

PART 2 - PRODUCTS

2.01 MATERIALS, GENERAL

- A. Porcelain-Enamel Face Sheet: Porcelain-enamel-clad, ASTM A 463/A 463M, Type 1, stretcher-leveled aluminized steel, with 0.024-inch uncoated thickness; with porcelain-enamel coating fused to steel at approximately 1000 deg F .
 - 1. Gloss Finish: Low gloss; dry-erase markers wipe clean with dry cloth or standard eraser. Suitable for use as projection screen.
 - a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Claridge Products and Equipment, Inc.; LCS Markerboard.
- B. Fiberboard: ASTM C 208.
- C. Extruded Aluminum: ASTM B 221 , Alloy 6063.
- D. Adhesives: Manufacturer's standard product that complies with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.02 MARKERBOARD ASSEMBLIES

- A. Porcelain-Enamel Markerboards: Balanced, high-pressure, factory-laminated markerboard assembly of three-ply construction consisting of backing sheet, core material, and 0.021-inch- thick, porcelain-enamel face sheet with high-gloss finish.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. AARCO Products, Inc.
 - b. ADP Lemco, Inc.
 - c. Claridge Products and Equipment, Inc.
 - d. Egan Visual Inc.
 - 2. Fiberboard Core: 7/16 thick; with 0.013-inch-thick, galvanized-steel sheet backing.
 - 3. Laminating Adhesive: Manufacturer's standard, moisture-resistant thermoplastic type.

2.03 MARKERBOARD ACCESSORIES

- A. Aluminum Frames and Trim: Fabricated from not less than 0.062-inch- thick, extruded aluminum; standard size and shape.
 - 1. Factory-Applied Trim: Manufacturer's standard.
- B. Chalktray: Manufacturer's standard, continuous.
 - 1. Box Type: Extruded aluminum with slanted front, grooved tray, and cast-aluminum end closures.

2.04 FABRICATION

- A. Porcelain-Enamel Visual Display Assemblies: Laminate porcelain-enamel face sheet and backing sheet to core material under heat and pressure with manufacturer's standard flexible, waterproof adhesive.
- B. Visual Display Boards: Factory assemble visual display boards unless otherwise indicated.
 - 1. Where factory-applied trim is indicated, trim shall be assembled and attached to visual display boards at manufacturer's factory before shipment.
- C. Aluminum Frames and Trim: Fabricate units straight and of single lengths, keeping joints to a minimum. Miter corners to a neat, hairline closure.
 - 1. Where factory-applied trim is indicated, trim shall be assembled and attached to visual display units at manufacturer's factory before shipment.

2.05 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.06 ALUMINUM FINISHES

- A. Clear Anodic Finish: AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances, surface conditions of wall, and other conditions affecting performance of the Work.
- B. Examine walls and partitions for proper preparation and backing for visual display surfaces.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Comply with manufacturer's written instructions for surface preparation.
- B. Clean substrates of substances that could impair the performance of and affect the smooth, finished surfaces of visual display boards, including dirt, mold, and mildew.
- C. Prepare surfaces to achieve a smooth, dry, clean surface free of flaking, unsound coatings, cracks, defects, projections, depressions, and substances that will impair bond between visual display surfaces and wall surfaces.

- D. Prepare recesses for sliding visual display units as required by type and size of unit.

3.03 INSTALLATION, GENERAL

- A. General: Install visual display surfaces in locations and at mounting heights indicated on Drawings, or if not indicated, at heights indicated below. Keep perimeter lines straight, level, and plumb. Provide grounds, clips, backing materials, adhesives, brackets, anchors, trim, and accessories necessary for complete installation.

3.04 INSTALLATION OF FACTORY-FABRICATED VISUAL DISPLAY BOARDS AND ASSEMBLIES

- A. Visual Display Boards: Attach concealed clips, hangers, and grounds to wall surfaces and to visual display boards with fasteners at not more than 16 inches o.c. Secure both top and bottom of boards to walls.
- B. Mounting heights: As shown on Drawings.

3.05 CLEANING AND PROTECTION

- A. Clean visual display surfaces according to manufacturer's written instructions. Attach one cleaning label to visual display surface in each room.
- B. Touch up factory-applied finishes to restore damaged or soiled areas.
- C. Cover and protect visual display surfaces after installation and cleaning.

END OF SECTION 10 11 16

SECTION 10 11 46**VISUAL DISPLAY WALL FABRICS - TACKABLE****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section Includes:
 - 1. Resilient cork and linoleum composition wall coverings intended for use as a tackable surface.
 - 2. Accessories including trim, and push pins.
- B. Related Sections:
 - 1. Division 09 Section "Interior Painting" for priming wall substrate.

1.03 DEFINITIONS

- A. Visual Display Fabrics: Fabrics with surfaces that are used to convey information visually, including surfaces of markerboards, tackboards, and surfacing materials that are not fabricated into composite panel form but are applied directly to walls.

1.04 SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for tackable wall fabrics and accessories.
- B. LEED Submittals:
 - 1. Product Data for Credit EQ 4.4: For composite wood products, documentation indicating that the product contains no urea formaldehyde.
 - 2. Product Data for Credit EQ 4.1: For adhesives, including printed statement of VOC content and chemical components.
- C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Show locations of fabric joints.
 - 2. Show locations of special-purpose graphics for tackable surfaces.
 - 3. Include sections of typical trim members.
- D. Samples for Initial Selection: For each type of tackable wall fabric indicated, for units with factory-applied color finishes, and as follows:
 - 1. Actual sections of tackable wall fabric.

2. Include accessory Samples to verify color selected.
- E. Samples for Verification: For each type of visual display surface indicated.
1. Tackable Wall Fabric: Not less than 7 by 9 inches, mounted on substrate indicated for final Work. Include one panel for each type, color, and texture required.
 2. Trim: 6-inch- long sections of each trim profile.
 3. Accessories: Full-size Sample of each type of accessory.
- F. Product Schedule: Use same designations indicated on Drawings.
- G. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for surface-burning characteristics of tackable wall covering.
- H. Maintenance Data: For to include in maintenance manuals.
- I. Warranties: Sample of special warranties.

1.05 QUALITY ASSURANCE

- A. Source Limitations: Obtain tackable fabrics and accessories from single source from single manufacturer.
- B. Surface-Burning Characteristics: Class B or better, as determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
1. Flame-Spread Index: 75 or less.
 2. Smoke-Developed Index: 450 or less.
- C. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate appearance and aesthetic effects and set quality standards for installation.
1. Build mockup of typical wall area as shown on Drawings. Include accessories. Include seams in locations intended for final installation.
 2. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Store tackable wall coverings, accessories, and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 68 deg F or more than 90 deg F. Store rolls upright.

1.07 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install tackable wall coverings and accessories until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above ceilings is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

- B. Maintain temperatures within range recommended by manufacturer, but not less than 68 deg F or more than 95 deg F, in spaces to receive tackable wall covering during the following time periods:
 - 1. 72 hours before installation.
 - 2. During installation.
 - 3. 72 hours after installation.
- C. After postinstallation period, maintain temperatures within range recommended by manufacturer, but not less than 55 deg F or more than 95 deg F.

1.08 WARRANTY

- A. Special Warranty for Tackable Wall Coverings: Manufacturer's standard form in which manufacturer agrees to repair or replace tackable wall coverings that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Surfaces lose original resilience.
 - b. Surfaces exhibit crazing, cracking, or flaking.
 - c. Sheet shrinks excessively (dimensional stability).
 - 2. Warranty Period: 5 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 MATERIALS, GENERAL

- A. Extruded Aluminum: ASTM B 221, Alloy 6063.

2.02 TACKABLE WALL COVERINGS

- A. Product: Subject to compliance with requirements, provide walltalkers; a division of RJF International Corporation; tac-wall.
- B. Description: A uniformly colored, resilient, homogeneous, tackable, linoleum surface consisting of linseed oil, granulated cork, rosin binders, and dry pigments calendared onto natural burlap backing. Color shall extend through thickness of material. Sheet material shall be dimensionally stable as installed.
 - 1. Roll Width: 72 inch.
 - 2. Roll Length: Approximately 95 lineal foot.
 - 3. Sheet Thickness (Gauge): 1/4 inch.
 - 4. Minimum Bending Radius (Flexibility): 2-3/4 inch.
- C. Adhesive: Mildew-resistant, nonstaining, strippable adhesive, for use with tackable wall covering and substrate application, as recommended in writing by wall covering manufacturer, and with a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- D. Joint Sealant: Tackable wall covering manufacturer's recommended acrylic sealant.

1. Color: As selected by Architect from manufacturer's full range.

E. Primer/Sealer: Mildew-resistant primer/sealer complying with requirements in Division 09 Section "Interior Painting" and recommended in writing by wall covering manufacturer for intended substrate.

2.03 VISUAL DISPLAY WALL COVERING ACCESSORIES

A. Aluminum Frames and Trim: Fabricated from not less than 0.062-inch- thick, extruded aluminum; standard size and shape.

1. Field-Applied Trim: Manufacturer's standard, screw-on trim with Phillips flat-head screws.

2.04 FABRICATION

A. Aluminum Frames and Trim: Fabricate units straight and of single lengths, keeping joints to a minimum. Miter corners to a neat, hairline closure.

2.05 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.06 ALUMINUM FINISHES

A. Clear Anodic Finish: AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances, surface conditions of wall, and other conditions affecting performance of the Work.

B. Examine walls and partitions for proper preparation and backing for tackable wall coverings.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Comply with manufacturer's written instructions for surface preparation.

- B. Clean substrates of substances that could impair the performance of and affect the smooth, finished surfaces of tackable wall covering, including dirt, mold, and mildew.
- C. Prepare surfaces to achieve a smooth, dry, clean surface free of flaking, unsound coatings, cracks, defects, projections, depressions, and substances that will impair bond between visual display wall covering and wall surfaces.
 - 1. Prime wall surfaces indicated to receive tackable wall coverings and as recommended in writing by primer/sealer manufacturer and wall covering manufacturer.
 - 2. Prepare surfaces to receive tackable wall coverings and test for moisture according to requirements specified in Division 09 Section "Wall Coverings."
 - 3. Prepare substrates indicated to receive visual display wall covering as required by manufacturer's written instructions to achieve a smooth, dry, clean, structurally sound surface that is uniform in color.
 - a. Moisture Content: Maximum of 5 percent when tested with an electronic moisture meter.
 - b. Plaster: Allow new plaster to cure. Neutralize areas of high alkalinity. Prime with primer as recommended in writing by primer/sealer manufacturer and wall covering manufacturer.
 - c. Metals: If not factory primed, clean and apply metal as recommended in writing by primer/sealer manufacturer and wall covering manufacturer.
 - d. Gypsum Board: Prime with primer as recommended in writing by primer/sealer manufacturer and wall covering manufacturer.
 - e. Painted Surfaces: Treat areas susceptible to pigment bleeding.

3.03 INSTALLATION, GENERAL

- A. General: Install tackable wall coverings and accessories in locations and at mounting heights indicated on Drawings, or if not indicated, at heights indicated below. Keep perimeter lines straight, level, and plumb. Provide grounds, clips, backing materials, adhesives, brackets, anchors, trim, and accessories necessary for complete installation.
 - 1. Mounting Height: 36 inches above finished floor to top of marker tray.

3.04 INSTALLATION OF TACKABLE WALL COVERING

- A. General: Comply with visual display wall covering manufacturers' written installation instructions.
- B. Cut sheets to size including a few inches of overage. Allow sheets to lay flat for at least 24 hours prior to the application. Mark roll direction and hanging sequence on the backside of each sheet.
- C. Back roll each sheet prior to the installation to release curl memory.
- D. Install seams horizontal and level, with lowest seam 36 inches above finished floor. Hang sheets in sequence as cut from the roll, do not reverse sheets. to ensure color matching.
- E. Double cut seams, with no gaps or overlaps. Remove air bubbles, wrinkles, blisters,

and other defects.

- F. Scribe, cut, and fit material to butt tightly to adjacent surfaces, built-in casework, and permanent fixtures and pipes.
- G. Trowel apply adhesive with a 1/16 inch square notch trowel to substrate receiving the sheet. Apply adhesive only in area receiving a single sheet.
- H. Apply sheet to substrate, roll firmly into adhesive to ensure positive contact and to remove air bubbles. Work from top to bottom, then side to side.
- I. Remove adhesive residue immediately after each sheet is hung with a mild soap and water solution, and a soft cloth or sponge.
- J. After installation, clean visual display wall covering according to manufacturer's written instructions. Remove excess adhesive at finished seams, perimeter edges, and adjacent surfaces.

3.05 INSTALLATION OF ACCESSORIES

- A. Field-Applied Aluminum Trim: Attach trim over edges of visual display wall covering with fasteners at not more than 24 inches o.c. Provide straight, single-length units. Keep joints to a minimum. Miter corners to a neat, hairline closure.
 - 1. Attach marker trays to wall with fasteners at not more than 12 inches o.c.

3.06 CLEANING AND PROTECTION

- A. Clean visual display surfaces according to manufacturer's written instructions. Attach one cleaning label to visual display surface in each room.
- B. Touch up factory-applied finishes to restore damaged or soiled areas.
- C. Cover and protect visual display surfaces after installation and cleaning.

END OF SECTION 10 11 46

SECTION 10 14 00**TRAFFIC SIGNAGE****PART I - GENERAL****1.1 SUMMARY****A. Description**

1. This Work includes the furnishing and installation of new signs, sign posts, parking meter posts, foundations and associated materials. It includes the removal of existing signs as shown on the Design Drawings and as specified herein.
2. Traffic signs shall conform to the requirements of local jurisdiction, the Missouri Department of Transportation (MODOT) Specifications, and the Manual on Uniform Traffic Control Devices (MUTCD), except as modified herein and specified on the Design Drawings. MODOT or the local jurisdiction's specifications shall apply based upon ownership of the roadway. If there is a conflict, the more stringent specification will apply.
3. Existing traffic signs shall be removed and salvaged in accordance with the requirements of the local jurisdiction or MODOT Specifications, except as modified herein and specified on the Design Drawings.

1.2 REFERENCES

<u>Sponsor</u>	<u>Number</u>	<u>Subject</u>
FHWA		Manual on Uniform Traffic Control Devices (MUTCD)
MODOT		Traffic Signs

1.3 SUBMITTALS AND INFORMATION TO BE RETAINED

- A. Submittals shall be made in accordance with the requirements of the Project Quality Plan, except as modified herein.
- B. Retain the following in accordance with KCMO's CM/GC General Conditions.
 1. Final Signing Design and layout.
 2. A certificate of compliance with specifications, detailed shop drawings, and wiring diagrams for the blankout signs and accessories.
 3. All manufacturer's warranties, guarantees, instruction sheets and parts lists.
- C. Submit three sets of drawings for overhead structures for prefabrication approval. Allow 14 calendar days for approval.

1.4 QUALITY ASSURANCE/QUALITY CONTROL

Quality control shall be in accordance with the requirements of the Project Quality Plan, except as modified herein.

1.5 DELIVERY HANDLING AND STORAGE

Materials shall be delivered to the site in undamaged condition and stored off the ground in a well-drained location protected from damage, easily accessible for inspection and handling.

PART II - PRODUCTS

2.1 MATERIALS

- A. Traffic signs, sign posts, foundations and associated materials shall conform to the requirements of the local jurisdiction, and MODOT Specifications and the Design Drawings.
- B. All signs, sign posts, foundations and associated materials shall be furnished by the Contractor.
- C. Reflectivity of the signs shall be in accordance with MUTCD and MODOT Specifications.
- D. Blankout (Interactive) Signs – A real time interactive sign stating “Train Coming”, Turn Prohibition or other appropriate message when activated, and blank when not activated, shall be placed where warranted, including but not limited to:
 - 1. Train and vehicles share the same physical space, for example a shared left turn lane.
 - 2. Vehicles will cross the train track for a turning movement.
 - 3. Driveway egress point which crosses Streetcar transit without protection.
 - 4. Unsignalized or stop controlled intersections.
 - 5. In combination with pedestrian signals if Streetcar station is to be used as a refuge.
 - 6. Any signal controlled movement that is activated by a Streetcar vehicle.

These signs shall be activated prior to the arrival of a train.

PART III - EXECUTION

3.1 SIGN INSTALLATION

- A. All traffic signs shown in the plans shall be furnished and installed by the Contractor in accordance with the requirements of the local jurisdiction, MODOT Specification, and the MUTCD, except as modified herein and specified on the Design Drawings.
- B. The Contractor shall mark on the Site the location for the proposed signs shown on the Design Drawings and shall conduct a Construction Design Review prior to installation. The Contractor shall not install any signs without written statement of no objection from the Engineer.
- C. The Contractor shall coordinate with the local jurisdiction or MODOT, 30 days prior to the installation of signs on the traffic signal mast-arms.
- D. The Contractor shall install signs as indicated on the Design Drawings.

- E. A ¾" stainless steel band with a 12-gauge insert plate painted with a semi-gloss black paint shall be used to place signs on OCS poles.
- F. Signs shall be covered securely with a durable material if erected before stated condition exists.

3.2 OVERHEAD CONTACT SYSTEM (OCS) POLE ISLAND

- A. The Contractor shall place 3" x 6" self adhesive yellow reflective High Angularity Diamond Grade sheeting on a 3" x 6" x 1/8" thick aluminum plate and adhere the plate to the OCS island with an outside adhesive.

3.3 REMOVAL AND SALVAGE OF EXISTING SIGNS

- A. Existing traffic signs shall be removed and salvaged in accordance with the requirements of MODOT Specifications, except as modified herein. The Contractor shall verify ownership of signs, and salvage and return signs to the respective owner per their specification.
- B. Existing signs that will conflict with the regulation of traffic and parking through construction and final configuration shall be removed or covered until the sign is again valid.

3.4 SIGN REPLACEMENT

The Contractor shall replace all local jurisdiction or MODOT signs that are removed during construction in accordance with local jurisdiction or MODOT standards.

PART IV - MEASUREMENT

4.1 Measurement

- A. The quantities of accepted work will be measured in the following units. All measurements will be plan measure except for authorized changes.
 - 1. Sign Removal (Posts) EA (Each)
 - 2. Sign Panel Removal EA
 - 3. Furnish & Install Signs SF (Square Foot)
 - 4. Posts Linear Foot LF (Linear Foot)
 - 5. Salvage and Install Signs EA
 - 6. Salvage and Reinstall Post EA
 - 7. Install City Furnished Signs EA

PART V - PAYMENT

5.1 Payment

Payment will be made at the respective unit or lump-sum price listed in the proposal and shall be full compensation for all labor, materials, and equipment necessary to complete the respective unit in place. There will be no separate measurement or payment for any item of

work not specifically identified and listed in the proposal, and all such work shall be considered a subsidiary item with all costs pertaining thereto included in the prices for other items listed in the proposal. At the Engineer's option, partial payment may be made for any lump sum item listed in the proposal, providing that the Contractor is diligently and satisfactorily pursuing full completion of such partially complete item in accordance with the approved job progress schedule.

END OF SECTION

SECTION 10 14 19**DIMENSIONAL LETTER SIGNAGE****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section Includes:
 - 1. Cutout dimensional characters.
- B. Application: Exterior building signage.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. LEED Submittals:
 - 1. Product Certificates for Credit MR 5: For products and materials required to comply with requirements for regionally manufactured materials. Include statement indicating cost for each regionally manufactured material.
 - a. Include statement indicating location of manufacturer and distance to Project for each regionally manufactured material.
- C. Shop Drawings: For dimensional letter signs.
 - 1. Include fabrication and installation details and attachments to other work.
 - 2. Show sign mounting heights, locations of supplementary supports to be provided by others, and accessories.
 - 3. Show message list, typestyles, graphic elements, and layout for each sign at least half size.
- D. Samples for Initial Selection: For each type of sign assembly, exposed component, and exposed finish.
 - 1. Include representative Samples of available typestyles and graphic symbols.
- E. Samples for Verification: For each type of sign assembly showing all components and with the required finish(es), in manufacturer's standard size unless otherwise indicated and as follows:
 - 1. Dimensional Characters: Full-size Sample of each type of dimensional character.
 - 2. Exposed Accessories: Full-size Sample of each accessory type.
- F. Sign Schedule: Use same designations specified or indicated on Drawings or in a sign schedule.

1.04 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer and manufacturer.
- B. Sample Warranty: For special warranty.

1.05 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For signs to include in maintenance manuals.

1.06 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are approved by manufacturer.

1.07 WARRANTY



- A. Special Warranty: Manufacturer agrees to repair or replace components of signs that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Deterioration of finishes beyond normal weathering.
 - b. Separation or delamination of sheet materials and components.
 - 2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 DIMENSIONAL LETTER SIGNS, GENERAL

- A. Regional Materials: Dimensional letter signs shall be manufactured within 500 miles of Project site.

2.02 DIMENSIONAL CHARACTERS

- A. Cutout Characters  Insert drawing designation : Characters with uniform faces; square-cut, smooth, eased edges; precisely formed lines and profiles; and as follows:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. ACE Sign Systems, Inc.
 - b. APCO Graphics, Inc.
 - c. A. R. K. Ramos Signage Systems.
 - d. ASI Sign Systems, Inc.
 - e. Charleston Industries, Inc.
 - f. Diskey Sign Company.
 - g. Gemini Incorporated.
 - h. InPro Corporation.
 - i. Matthews International Corporation; Bronze Division.
 - j. Metal Arts; Division of L & H Mfg. Co.
 - k. Metallic Arts.
 - l. Nelson-Harkins Industries.
 - m. Southwell Company (The).
 - n. Steel Art Company.

2. Character Material: Sheet or plate aluminum
3. Character Height: As indicated.
4. Thickness: Manufacturer's standard for size of character
5. Finishes:
 - a. Baked-Enamel or Powder-Coat Finish: Match Architect's sample.
 - b. Overcoat: Manufacturer's standard baked-on clear coating.
 - c. Painted Edges: Paint edges of acrylic characters with laminated metal facing as recommended in writing by manufacturer.
6. Mounting: Projecting studs.

2.03 DIMENSIONAL CHARACTER MATERIALS

- A. Aluminum Sheet and Plate: [ASTM B 209](#), alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.
- B. Aluminum Extrusions: [ASTM B 221](#), alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.

2.04 ACCESSORIES

- A. Fasteners and Anchors: Manufacturer's standard as required for secure anchorage of signage, noncorrosive and compatible with each material joined, and complying with the following:
 1. Use concealed fasteners and anchors unless indicated to be exposed.
 2. For exterior exposure, furnish stainless-steel or hot-dip galvanized devices unless otherwise indicated.
 3. Exposed Metal-Fastener Components, General:
 - a. Fabricated from same basic metal and finish of fastened metal unless otherwise indicated.
 - b. Fastener Heads: For nonstructural connections, use [flathead] [or] [oval countersunk] [Insert shape] screws and bolts with tamper-resistant [Allen-head] [spanner-head] [or] [one-way-head] [Insert slot design] slots unless otherwise indicated.
 4. Sign Mounting Fasteners:
 - a. Projecting Studs: Threaded studs with sleeve spacer, welded or brazed to back of sign material, screwed into back of sign assembly, or screwed into tapped lugs cast integrally into back of cast sign material, unless otherwise indicated.
- B. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

2.05 FABRICATION

- A. General: Provide manufacturer's standard sign assemblies according to requirements indicated.
 1. Preassemble signs and assemblies in the shop to greatest extent possible. Disassemble signs and assemblies only as necessary for shipping and handling limitations. Clearly mark units for reassembly and installation; apply markings in locations concealed from view after final assembly.
 2. Mill joints to a tight, hairline fit. Form assemblies and joints exposed to weather

- to resist water penetration and retention.
3. Comply with AWS for recommended practices in welding and brazing. Provide welds and brazes behind finished surfaces without distorting or discoloring exposed side. Clean exposed welded and brazed connections of flux, and dress exposed and contact surfaces.
 4. Conceal connections if possible; otherwise, locate connections where they are inconspicuous.
 5. Internally brace signs for stability and for securing fasteners.
 6. Provide rebates, lugs, and brackets necessary to assemble components and to attach to existing work. Drill and tap for required fasteners. Use concealed fasteners where possible; use exposed fasteners that match sign finish.
 7. Castings: Fabricate castings free of warp, cracks, blowholes, pits, scale, sand holes, and other defects that impair appearance or strength. Grind, wire brush, sandblast, and buff castings to remove seams, gate marks, casting flash, and other casting marks before finishing.
- B. Brackets: Fabricate brackets, fittings, and hardware for bracket-mounted signs to suit sign construction and mounting conditions indicated. Modify manufacturer's standard brackets as required.
1. Aluminum Brackets: Factory finish brackets with baked-enamel or powder-coat finish [to match sign-background color] [to match Architect's sample] [Insert requirement] color unless otherwise indicated.
 2. Stainless-Steel Brackets: Factory finish brackets [to match sign background] [to match Architect's sample] [with No. 4] [Insert finish] finish unless otherwise indicated.

2.06 GENERAL FINISH REQUIREMENTS

- A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- C. Organic, Anodic, and Chemically Produced Finishes: Apply to formed metal after fabrication but before applying contrasting polished finishes on raised features unless otherwise indicated.

2.07 ALUMINUM FINISHES

- A. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 1.5 mils. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of signage work.
- B. Verify that sign-support surfaces are within tolerances to accommodate signs without gaps or irregularities between backs of signs and support surfaces unless otherwise

indicated.

- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. General: Install signs using mounting methods indicated and according to manufacturer's written instructions.

1. Install signs level, plumb, true to line, and at locations and heights indicated, with sign surfaces free of distortion and other defects in appearance.
2. Before installation, verify that sign surfaces are clean and free of materials or debris that would impair installation.
3. Corrosion Protection: Coat concealed surfaces of exterior aluminum in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.

- B. Mounting Methods:

1. Projecting Studs: Using a template, drill holes in substrate aligning with studs on back of sign. Remove loose debris from hole and substrate surface.
 - a. Masonry Substrates: Fill holes with adhesive. Leave recess space in hole for displaced adhesive. Place spacers on studs, place sign in position, and push until spacers are pinched between sign and substrate, embedding the stud ends in holes. Temporarily support sign in position until adhesive fully sets.
 - b. Thin or Hollow Surfaces: Place spacers on studs, place sign in position with spacers pinched between sign and substrate, and install washers and nuts on stud ends projecting through opposite side of surface, and tighten.
2. Through Fasteners: Drill holes in substrate using predrilled holes in sign as template. Countersink holes in sign if required. Place sign in position and flush to surface. Install through fasteners and tighten.
3. Back Bar and Brackets: Remove loose debris from substrate surface and install backbar or bracket supports in position so that signage is correctly located and aligned.
4. Adhesive: Clean bond-breaking materials from substrate surface and remove loose debris. Apply linear beads or spots of adhesive symmetrically to back of sign and of suitable quantity to support weight of sign after cure without slippage. Keep adhesive away from edges to prevent adhesive extrusion as sign is applied and to prevent visibility of cured adhesive at sign edges. Place sign in position, and push to engage adhesive. Temporarily support sign in position until adhesive fully sets.

3.03 ADJUSTING AND CLEANING

- A. Remove and replace damaged or deformed characters and signs that do not comply with specified requirements. Replace characters with damaged or deteriorated finishes or components that cannot be successfully repaired by finish touchup or similar minor repair procedures.
- B. Remove temporary protective coverings and strippable films as signs are installed.

- C. On completion of installation, clean exposed surfaces of signs according to manufacturer's written instructions, and touch up minor nicks and abrasions in finish. Maintain signs in a clean condition during construction and protect from damage until acceptance by Owner.

END OF SECTION 10 14 19

SECTION 10 14 23**PANEL SIGNAGE****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY**A. Section Includes:**

1. Panel signs.
2. Room-identification signs.
3. Field-applied, vinyl-character signs.

B. Related Requirements:

1. Section 01 50 00 "Temporary Facilities and Controls" for temporary Project identification signs and for temporary information and directional signs.
2. Section 22 05 53 "Identification for Plumbing Piping and Equipment" for labels, tags, and nameplates for plumbing systems and equipment.
3. Section 23 05 53 "Identification for HVAC Piping and Equipment" for labels, tags, and nameplates for HVAC systems and equipment.
4. Section 26 05 53 "Identification for Electrical Systems" for labels, tags, and nameplates for electrical equipment.
5. Section 26 51 00 "Interior Lighting" for illuminated, self-luminous, and photoluminescent exit sign units.

1.03 DEFINITIONS

- A. Accessible: In accordance with the accessibility standard.

1.04 COORDINATION

- A. Furnish templates for placement of sign-anchorage devices embedded in permanent construction by other installers.
- B. Furnish templates for placement of electrical service embedded in permanent construction by other installers.

1.05 ACTION SUBMITTALS

- A. Product Data: For each type of product.

B. LEED Submittals:

1. Product Certificates for Credit MR 5: For products and materials required to comply with requirements for regionally manufactured materials. Include statement indicating cost for each regionally manufactured material.
 - a. Include statement indicating location of manufacturer and distance to Project for each regionally manufactured material.

2. Product Data for Credit IEQ 4.1: For adhesives, documentation including printed statement of VOC content.
- C. Shop Drawings: For panel signs.
1. Include fabrication and installation details and attachments to other work.
 2. Show sign mounting heights, locations of supplementary supports to be provided by others, and accessories.
 3. Show message list, typestyles, graphic elements, including raised characters and Braille, and layout for each sign at least half size.
 4. Show locations of electrical service connections.
 5. Include diagrams for power, signal, and control wiring.
- D. Samples for Initial Selection: For each type of sign assembly, exposed component, and exposed finish.
1. Include representative Samples of available typestyles and graphic symbols.
- E. Samples for Verification: For each type of sign assembly showing all components and with the required finish(es), in manufacturer's standard size unless otherwise indicated and as follows:
1. Panel Signs: [Full-size Sample] [Not less than 12 inches square, including corner] [Insert size].
 2. Room-Identification Signs: [Full-size Sample] [Insert size].
 3. Field-Applied, Vinyl-Character Signs: [Full-size Sample of characters on glass] [Insert requirement].
 4. Variable Component Materials: [Full-size Sample] [8-inch Sample] [Insert size] of each base material, character (letter, number, and graphic element) in each exposed color and finish not included in Samples above.
 5. Exposed Accessories: [Full-size Sample] [Half-size Sample] [Insert size] of each accessory type.
- F. Sign Schedule: Use same designations specified or indicated on Drawings or in a sign schedule.
- G. Delegated-Design Submittal: For [signs indicated in "Performance Requirements" Article] [Insert sign designations].
1. Include structural analysis calculations for signs indicated to comply with design loads; signed and sealed by the qualified professional engineer responsible for their preparation.

1.06 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For [Installer] [and] [manufacturer].
- B. Sample Warranty: For special warranty.

1.07 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For signs to include in maintenance manuals.

1.08 QUALITY ASSURANCE

- A. Installer Qualifications: [Manufacturer of products] [An entity that employs installers and supervisors who are trained and approved by manufacturer].

1.09 FIELD CONDITIONS

- A. Field Measurements: Verify locations of anchorage devices and electrical service embedded in permanent construction by other installers by field measurements before fabrication, and indicate measurements on Shop Drawings.

1.10 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of signs that fail in materials or workmanship within specified warranty period.
1. Failures include, but are not limited to, the following:
 - a. Deterioration of finishes beyond normal weathering.
 - b. Deterioration of embedded graphic image.
 - c. Separation or delamination of sheet materials and components.
 2. Warranty Period: Five <Insert number> years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 PANEL SIGNS, GENERAL

- A. Regional Materials: Panel signs shall be manufactured within 500 miles of Project site.

2.02 PERFORMANCE REQUIREMENTS

- A. Thermal Movements: For exterior signs, allow for thermal movements from ambient and surface temperature changes.
1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces <Insert temperature change>.
- B. Accessibility Standard: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines for Buildings and Facilities and ICC A117.1 for signs.

2.03 SIGNS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Ace Sign Systems, Inc.
 2. Advance Corporation; Braille-Tac Division.
 3. Allen Industries, Inc.
 4. Allen Markings International.
 5. APCO Graphics, Inc.
 6. ASE, Inc.
 7. ASI Sign Systems, Inc.
 8. Best Sign Systems Inc.
 9. Bunting Graphics, Inc.
 10. Clarke Systems.
 11. Diskey Sign Company.
 12. Fossil Industries, Inc.

13. InPro Corporation.
14. Mohawk Sign Systems.
15. Nelson-Harkins Industries.
16. Poblocki Sign Company, LLC.
17. Seton Identification Products.
18. Supersine Company (The); Division of Stamp-Rite, Inc.
19. Vista System.
20. Vomar Products, Inc.

- B. Panel Sign Insert drawing designation: Sign with smooth, uniform surfaces; with message and characters having uniform faces, sharp corners, and precisely formed lines and profiles; and as follows:
1. Basis-of-Design Product: Indicated on Drawings Insert manufacturer's name; product name or designation.
 2. Solid-Sheet Sign and Returns, Returns, and Back: Aluminum Brass Bronze Copper Steel Stainless-steel Acrylic Fiberglass PVC Insert material sheet with finish specified in "Surface Finish and Applied Graphics" Subparagraph below and as follows:
 - a. Thickness: As indicated Manufacturer's standard for size of sign 0.060 inch 0.080 inch 0.125 inch 0.25 inch Insert dimension.
 - b. Surface-Applied Graphics: Applied vinyl film baked enamel or powder coat paint photo image Insert requirement.
 - c. Etched and Filled Graphics: Sign face etched or routed to receive enamel-paint infill.
 - d. Inset, Cutout Characters: Sign face routed to receive push-through acrylic graphics flush with slightly projecting from the sign panel.
 3. Laminated Aluminum-Sheet Sign: Aluminum sheet laminated to both sides of acrylic phenolic Insert material core sheet with painted edges.
 - a. Composite-Sheet Thickness: As indicated Manufacturer's standard for size of sign 0.125 inch 0.25 inch Insert dimension.
 - b. Surface-Applied Graphics: Applied vinyl film paint photo image Insert requirement.
 4. Laminated-Sheet Sign: Photopolymer Sandblasted polymer Insert material face sheet with raised graphics laminated over subsurface graphics to acrylic phenolic Insert material backing sheet to produce composite sheet.
 - a. Composite-Sheet Thickness: As indicated Manufacturer's standard for size of sign 0.125 inch 0.25 inch Insert dimension.
 - b. Surface-Applied Graphics: Applied vinyl film paint photo image Insert requirement.
 - c. Subsurface Graphics: Reverse halftone or dot-screen image Reverse etch image Snap-in changeable insert beneath removable face sheet Slide-in changeable insert Insert requirement.
 5. Composite Phenolic-Core Sign: Solid phenolic panel core with integral subsurface graphic image covered with integral, polymeric face layer.
 - a. Composite-Sheet Thickness: As indicated Manufacturer's standard for size of sign 0.5 inch 1 inch Insert dimension.
 6. Laminated Polycarbonate-Sheet Sign: Polycarbonate face sheet laminated to each side of phenolic Insert material base sheet to produce composite sheet.

- a. Composite-Sheet Thickness: [As indicated] [Manufacturer's standard for size of sign] [0.125 inch] [0.25 inch] <Insert dimension>.
 - b. Surface-Applied Graphics: Applied [vinyl film] [paint] [photo image] <Insert requirement>.
 - c. Subsurface Graphics: [Reverse halftone or dot-screen image] [Reverse etch image] <Insert requirement>.
7. Engraved Plastic-Laminate Sign: Plastic-laminate face laminated to contrasting phenolic core to produce composite sheet.
- a. Composite-Sheet Thickness: [As indicated] [Manufacturer's standard for size of sign] [0.125 inch] [0.25 inch] <Insert dimension>.
 - b. Engraved Graphics: Characters engraved through plastic-laminate face sheet to expose contrasting phenolic core.
 - c. Plastic-Laminate Color and Pattern: [As indicated by manufacturer's designation] [As selected by Architect from manufacturer's full range] <Insert color and pattern>.
 - d. Core Color: Manufacturer's standard [dark color] <Insert color>.
8. Sign-Panel Perimeter: Finish edges smooth.
- a. Edge Condition, Vertical Edges, Horizontal Edges: [As indicated] [Square cut] [Beveled] [Bullnosed] <Insert requirement>.
 - b. Corner Condition in Elevation: [As indicated] [Square] [Rounded to radius indicated] <Insert requirement>.
9. Frame: [Entire perimeter] [Horizontal retainers] [Vertical retainers] [to hold changeable sign panel] <Insert description>.
- a. Material: [Aluminum] [Brass] [Bronze] [Steel] [Stainless steel] [PVC] <Insert material>.
 - b. Material Thickness: <Insert dimension>.
 - c. Frame Depth: [As indicated] <Insert dimension>.
 - d. Profile: [Square] [Beveled] [Rounded] <Insert requirement>.
 - e. Corner Condition in Elevation: [Square] [Mitered] [Rounded to radius indicated] <Insert requirement>.
 - f. Finish and Color: [Mill] [Painted, matte black color] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert requirement>.
10. Mounting: [As indicated] [Manufacturer's standard method for substrates indicated] [Surface mounted to wall] [Projecting from wall] [Suspended] [Aluminum bracket] [Stainless-steel bracket] <Insert requirement> with [concealed anchors] [countersunk flathead through fasteners] [adhesive] [two-face tape] [hook-and-loop tape] [or] [magnetic tape].
11. Surface Finish and Applied Graphics:
- a. Integral Metal Finish: [Mill] [Antique oxidized] [As indicated by manufacturer's designation] [Match Architect's sample] [As selected by Architect from full range of industry finishes] <Insert finish>.
 - b. Integral Aluminum Finish: [Clear anodized] [Light bronze anodized] [Medium bronze anodized] [Match Architect's sample] [Anodized color as selected by Architect from full range of industry colors and color densities] <Insert finish>.
 - c. Integral Stainless-Steel Finish: [No. 4] [No. 8] [Match Architect's sample] [As selected by Architect from full range of industry finishes] <Insert description>.
 - d. Integral [Acrylic] [Fiberglass] [PVC] Sheet Color: [As indicated by manufacturer's designation] [Match Architect's sample] [As selected by

- e. Architect from full range of industry colors. <Insert color>.
- e. Baked-Enamel or Powder-Coat Finish and Graphics: Manufacturer's standard, in color [as indicated by manufacturer's designation] [matching Architect's sample] [as selected by Architect from manufacturer's full range] <Insert color>.
- f. Painted Finish and Graphics: Manufacturer's standard, factory-applied [exterior-grade sign paint] [acrylic polyurethane] <Insert requirement>, in color [as indicated by manufacturer's designation] [matching Architect's sample] [as selected by Architect from manufacturer's full range] <Insert color>.
- g. Photo-Image Graphics: Manufacturer's standard [black-and-white] [multicolor], [600-dpi] <Insert value> halftone or dot-screen image.
- h. Overcoat: [Manufacturer's standard baked-on clear coating] <Insert requirement>.
12. Text and Typeface: [Accessible raised characters and Braille] [Times Roman] [typeface as indicated by manufacturer's designation] [typeface matching Architect's sample] [typeface as selected by Architect from manufacturer's full range] [and] [variable content as scheduled] <Insert requirement>. Finish raised characters to contrast with background color, and finish Braille to match background color.]
13. Flatness Tolerance: Sign panel shall remain flat or uniformly curved under installed conditions as indicated and within a tolerance of plus or minus [1/16 inch] <Insert dimension> measured diagonally from corner to corner.
- C. Room-Identification Sign <Insert drawing designation>: Sign with smooth, uniform surfaces; with message and characters having uniform faces, sharp corners, and precisely formed lines and profiles; and as follows:
1. Basis-of-Design Product: [Indicated on Drawings] <Insert manufacturer's name; product name or designation>.
 2. Laminated-Sheet Sign: [Photopolymer] [Sandblasted polymer] <Insert material> face sheet with raised graphics laminated [over subsurface graphics] to [acrylic] [phenolic] <Insert material> backing sheet to produce composite sheet.
 - a. Composite-Sheet Thickness: [As indicated] [Manufacturer's standard for size of sign] [0.125 inch] [0.25 inch] <Insert dimension>.
 - b. Surface-Applied Graphics: Applied [vinyl film] [paint] [photo image] <Insert requirement>.
 - c. Subsurface Graphics: [Reverse halftone or dot-screen image] [Reverse etch image] [Snap-in changeable insert beneath removable face sheet] [Slide-in changeable insert] <Insert requirement>.
 - d. Color(s): [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert requirement>.
 3. Sign-Panel Perimeter: Finish edges smooth.
 - a. Edge Condition: [As indicated] [Square cut] [Beveled] [Bullnosed] <Insert requirement>.
 - b. Corner Condition in Elevation: [As indicated] [Square] [Rounded to radius indicated] <Insert requirement>.
 4. Frame: [Aluminum] <Insert material>.
 - a. Material Thickness: <Insert dimension>.
 - b. Frame Depth: [As indicated] [Convex-curved frame to receive removable face sheet and changeable subsurface graphics] <Insert dimension>.
 - c. Profile: [Square] [Beveled] [Rounded] <Insert requirement>.

- d. Corner Condition in Elevation: [Square] [Mitered] [Rounded to radius indicated] <Insert requirement>.
 - e. Finish and Color: [Mill] [Painted, matte black color] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert requirement>.
5. Mounting: [Manufacturer's standard method for substrates indicated] [Surface mounted to wall] with [concealed anchors] [countersunk flathead through fasteners] [adhesive] [two-face tape] [hook-and-loop tape] [or] [magnetic tape].
 6. Text and Typeface: [Accessible raised characters and Braille] [Times Roman] [typeface as indicated by manufacturer's designation] [typeface matching Architect's sample] [typeface as selected by Architect from manufacturer's full range] [and] [variable content as scheduled] <Insert requirement>. Finish raised characters to contrast with background color, and finish Braille to match background color.

2.04 FIELD-APPLIED, VINYL-CHARACTER SIGNS

- A. Field-Applied, Vinyl-Character Sign <Insert drawing designation>: Prespaced characters die cut from [3- to 3.5-mil] <Insert dimensions> thick, weather-resistant vinyl film with release liner on the back and carrier film on the front for on-site alignment and application.
 1. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
 2. Basis-of-Design Product: Subject to compliance with requirements, provide [product indicated on Drawings] <Insert manufacturer's name>; product name or designation > or comparable product by one of the following:
 - a. Allen Markings International.
 - b. APCO Graphics, Inc.
 - c. ASI Sign Systems, Inc.
 - d. Best Sign Systems Inc.
 - e. Mohawk Sign Systems.
 - f. Nelson-Harkins Industries.
 - g. Seton Identification Products.
 - h. <Insert manufacturer's name>.
 3. Size: [As indicated] [As scheduled] <Insert requirement>.
 4. Substrate: [As indicated] [As scheduled] [Glass] [Doors] [Walls] <Insert substrate>.
 5. Text and Font: [As indicated] [As scheduled] <Insert requirement>.

2.05 PANEL-SIGN MATERIALS

- A. Aluminum Sheet and Plate: [ASTM B 209](#), alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.
- B. Aluminum Extrusions: [ASTM B 221](#), alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.
- C. Brass Sheet (Yellow Brass): [ASTM B 36/B 36M](#), [alloy recommended by manufacturer and finisher for finish indicated] [lead-free alloy recommended by manufacturer and finisher for finish indicated] [Alloy UNS No. C26000 (yellow brass)] <Insert requirement>.

- D. Bronze Plate: ASTM B 36/B 36M, [alloy recommended by manufacturer and finisher for finish indicated] [lead-free alloy recommended by manufacturer and finisher for finish indicated] [Alloy UNS No. C22000 (commercial bronze)] [Insert requirement].
- E. Copper Sheet: ASTM B 152/B 152M.
- F. Steel Materials:
1. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, [G90] [Insert coating designation] coating, either commercial or forming steel.
 2. Steel Sheet: [Uncoated, cold-rolled, ASTM A 1008/A 1008M, commercial steel, Type B, exposed] [or] [electrolytic zinc-coated, ASTM A 879/A 879M, Coating Designation 08Z, with steel-sheet substrate according to ASTM A 1008/A 1008M, commercial steel, exposed].
 3. Steel Members Fabricated from Plate or Bar Stock: ASTM A 529/A 529M or ASTM A 572/A 572M, 42,000-psi minimum yield strength.
 4. For steel exposed to view on completion, provide materials having flat, smooth surfaces without blemishes. Do not use materials whose surfaces exhibit pitting, seam marks, roller marks, rolled trade names, or roughness.
- G. Stainless-Steel Sheet: ASTM A 240/A 240M or ASTM A 666, [Type 304,] [Type 316,] stretcher-leveled standard of flatness.
- H. Acrylic Sheet: ASTM D 4802, category as standard with manufacturer for each sign, Type UVF (UV filtering).
- I. Polycarbonate Sheet: ASTM C 1349, Appendix X1, Type II (coated, mar-resistant, UV-stabilized polycarbonate), with coating on both sides.
- J. Fiberglass Sheet: Multiple laminations of glass-fiber-reinforced polyester resin with UV-light stable, colorfast, nonfading, weather- and stain-resistant, colored polyester gel coat, and with manufacturer's standard finish.
- K. PVC Sheet: Manufacturer's standard, UV-light stable, PVC plastic.
- L. Plastic-Laminate Sheet: NEMA LD 3, general-purpose HGS grade, 0.048-inch nominal thickness.
- M. Vinyl Film: UV-resistant vinyl film of nominal thickness indicated, with pressure-sensitive, permanent adhesive on back; die cut to form characters or images as indicated and suitable for exterior applications.
- N. Paints and Coatings for Sheet Materials: Inks, dyes, and paints that are recommended by manufacturer for optimum adherence to surface and are UV and water resistant for colors and exposure indicated.

2.06 ACCESSORIES

- A. Fasteners and Anchors: Manufacturer's standard as required for secure anchorage of signage, noncorrosive and compatible with each material joined, and complying with the following:
1. Use concealed fasteners and anchors unless indicated to be exposed.
 2. For exterior exposure, furnish [nonferrous-metal] [stainless-steel] [or] [hot-dip galvanized] [Insert requirement] devices unless otherwise indicated.
 3. Exposed Metal-Fastener Components, General:
 - a. Fabricated from same basic metal and finish of fastened metal unless

- otherwise indicated.
- b. Fastener Heads: For nonstructural connections, use flathead or oval countersunk insert shape screws and bolts with tamper-resistant Allen-head, spanner-head, or one-way-head insert slot design slots unless otherwise indicated.
4. Sign Mounting Fasteners:
 - a. Concealed Studs: Concealed (blind), threaded studs welded or brazed to back of sign material or screwed into back of sign assembly, unless otherwise indicated.
 - b. Projecting Studs: Threaded studs with sleeve spacer, welded or brazed to back of sign material or screwed into back of sign assembly, unless otherwise indicated.
 - c. Through Fasteners: Exposed metal fasteners matching sign finish, with type of head indicated, installed in predrilled holes.
 5. Inserts: Furnish inserts to be set by other trades into concrete or masonry work.
- B. Adhesives: As recommended by sign manufacturer and with a VOC content of 70 g/L or less for adhesives used inside the weatherproofing system and applied on-site when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - C. Adhesives: As recommended by sign manufacturer and that comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
 - D. Two-Face Tape: Manufacturer's standard high-bond, foam-core tape, 0.045 inch thick, with adhesive on both sides.
 - E. Hook-and-Loop Tape: Manufacturer's standard two-part tape consisting of hooked part on sign back and looped side on mounting surface.
 - F. Magnetic Tape: Manufacturer's standard magnetic tape with adhesive on one side.
 - G. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

2.07 FABRICATION

- A. General: Provide manufacturer's standard sign assemblies according to requirements indicated.
 1. Preassemble signs and assemblies in the shop to greatest extent possible. Disassemble signs and assemblies only as necessary for shipping and handling limitations. Clearly mark units for reassembly and installation; apply markings in locations concealed from view after final assembly.
 2. Mill joints to a tight, hairline fit. Form assemblies and joints exposed to weather to resist water penetration and retention.
 3. Comply with AWS for recommended practices in welding and brazing. Provide welds and brazes behind finished surfaces without distorting or discoloring exposed side. Clean exposed welded and brazed connections of flux, and dress exposed and contact surfaces.
 4. Conceal connections if possible; otherwise, locate connections where they are inconspicuous.
 5. Internally brace signs for stability and for securing fasteners.
 6. Provide rebates, lugs, and brackets necessary to assemble components and to attach to existing work. Drill and tap for required fasteners. Use concealed

fasteners where possible; use exposed fasteners that match sign finish.

- B. **Surface-Engraved Graphics:** Machine engrave characters and other graphic devices into panel surface indicated to produce precisely formed copy, incised to uniform depth.
1. **Engraved Metal:** Fill engraved graphics with manufacturer's standard baked enamel.
 2. **Engraved Opaque Acrylic Sheet:** Fill engraved graphics with manufacturer's standard enamel.
 3. **Face-Engraved Clear Acrylic Sheet:** Fill engraved copy with manufacturer's standard enamel. Apply manufacturer's standard opaque background color coating to back face of acrylic sheet.
 4. **Engraved Plastic Laminate:** Engrave through exposed face ply of plastic-laminate sheet to expose contrasting core ply.
- C. **Subsurface-Applied Graphics:** Apply graphics to back face of clear face-sheet material to produce precisely formed image. Image shall be free of rough edges.
- D. **Subsurface-Engraved Graphics:** Reverse engrave back face of clear face-sheet material. Fill resulting copy with manufacturer's standard enamel. Apply opaque manufacturer's standard background color coating over enamel-filled copy.
- E. **Shop- and Subsurface-Applied Vinyl:** Align vinyl film in final position and apply to surface. Firmly press film from the middle outward to obtain good bond without blisters or fishmouths.
- F. **Signs with Changeable Message Capability:** Fabricate signs to allow insertion of changeable messages as follows:
1. For snap-in changeable inserts beneath removable face sheet, furnish one suction or other device to assist in removing face sheet. Furnish initial changeable insert. [Subsequent changeable inserts are by Owner] [Furnish two blank inserts for each sign for Owner's use] [Insert requirement].
 2. For slide-in changeable inserts, fabricate slot without burrs or constrictions that inhibit function. Furnish initial changeable insert. [Subsequent changeable inserts are by Owner] [Furnish two blank inserts for each sign for Owner's use] [Insert requirement].
 3. For frame to hold changeable sign panel, fabricate frame without burrs or constrictions that inhibit function. Furnish initial sign panel. [Subsequent changeable sign panels are by Owner] [Insert requirement].
- G. **Brackets:** Fabricate brackets, fittings, and hardware for bracket-mounted signs to suit sign construction and mounting conditions indicated. Modify manufacturer's standard brackets as required.
1. **Aluminum Brackets:** Factory finish brackets with baked-enamel or powder-coat finish [to match sign-background color] [to match Architect's sample] [Insert requirement] color unless otherwise indicated.
 2. **Stainless-Steel Brackets:** Factory finish brackets [to match sign background] [to match Architect's sample] [with No. 4] [Insert finish] finish unless otherwise indicated.

2.08 GENERAL FINISH REQUIREMENTS

- A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

- B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- C. Directional Finishes: Run grain with long dimension of each piece and perpendicular to long dimension of finished trim or border surface unless otherwise indicated.
- D. Organic, Anodic, and Chemically Produced Finishes: Apply to formed metal after fabrication but before applying contrasting polished finishes on raised features unless otherwise indicated.

2.09 ALUMINUM FINISHES

- A. Clear Anodic Finish: AAMA 611, [Class I, 0.018 mm] [Class II, 0.010 mm] or thicker.
- B. Color Anodic Finish: AAMA 611, [Class I, 0.018 mm] [Class II, 0.010 mm] or thicker.
- C. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 1.5 mils. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

2.10 METALLIC-COATED STEEL FINISHES

- A. Surface Preparation: Clean surfaces of oil and other contaminants. Use cleaning methods that do not leave residue. After cleaning, apply a conversion coating compatible with the organic coating to be applied over it. Clean welds, mechanical connections, and abraded areas and apply galvanizing repair paint, complying with SSPC-Paint 20, to comply with ASTM A 780/A 780M.
- B. Factory Prime Finish: After cleaning and pretreating, apply an air-dried primer compatible with the organic coating to be applied over it.
- C. Baked-Enamel or Powder-Coat Finish: After cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat to a minimum dry film thickness of 2 mils.

2.11 STEEL FINISHES

- A. Surface Preparation: Remove mill scale and rust, if present, from uncoated steel, and prepare for coating according to coating manufacturer's written instructions.
 - 1. For Baked-Enamel or Powder-Coat Finish: After cleaning, apply a conversion coating compatible with the organic coating to be applied over it.
- B. Factory Prime Finish: After surface preparation and pretreatment, apply manufacturer's standard, fast-curing, lead- and chromate-free, universal primer.
- C. Baked-Enamel or Powder-Coat Finish: After cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat to a minimum dry film thickness of 2 mils.

2.12 STAINLESS-STEEL FINISHES

- A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
- B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross

scratches.

1. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
2. Directional Satin Finish: No. 4.
3. Dull Satin Finish: No. 6.
4. Reflective, Directional Polish: No. 7.
5. Mirrorlike Reflective, Nondirectional Polish: No. 8.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of signage work.
- B. Verify that sign-support surfaces are within tolerances to accommodate signs without gaps or irregularities between backs of signs and support surfaces unless otherwise indicated.
- C. Verify that anchor inserts are correctly sized and located to accommodate signs.
- D. Verify that electrical service is correctly sized and located to accommodate signs.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. General: Install signs using mounting methods indicated and according to manufacturer's written instructions.
 1. Install signs level, plumb, true to line, and at locations and heights indicated, with sign surfaces free of distortion and other defects in appearance.
 2. Install signs so they do not protrude or obstruct according to the accessibility standard.
 3. Before installation, verify that sign surfaces are clean and free of materials or debris that would impair installation.
 4. Corrosion Protection: Coat concealed surfaces of exterior aluminum in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.
- B. Room-Identification Signs and Other Accessible Signage: Install in locations on walls as indicated and according to accessibility standard. Insert requirement.
- C. Mounting Methods:
 1. Concealed Studs: Using a template, drill holes in substrate aligning with studs on back of sign. Remove loose debris from hole and substrate surface.
 - a. Masonry Substrates: Fill holes with adhesive. Leave recess space in hole for displaced adhesive. Place sign in position and push until flush to surface, embedding studs in holes. Temporarily support sign in position until adhesive fully sets.
 - b. Thin or Hollow Surfaces: Place sign in position and flush to surface, install washers and nuts on studs projecting through opposite side of surface, and tighten.

2. Projecting Studs: Using a template, drill holes in substrate aligning with studs on back of sign. Remove loose debris from hole and substrate surface.
 - a. Masonry Substrates: Fill holes with adhesive. Leave recess space in hole for displaced adhesive. Place spacers on studs, place sign in position, and push until spacers are pinched between sign and substrate, embedding the stud ends in holes. Temporarily support sign in position until adhesive fully sets.
 - b. Thin or Hollow Surfaces: Place spacers on studs, place sign in position with spacers pinched between sign and substrate, and install washers and nuts on stud ends projecting through opposite side of surface, and tighten.
 3. Through Fasteners: Drill holes in substrate using predrilled holes in sign as template. Countersink holes in sign if required. Place sign in position and flush to surface. Install through fasteners and tighten.
 4. Brackets: Remove loose debris from substrate surface and install backbar or bracket supports in position so that signage is correctly located and aligned.
 5. Adhesive: Clean bond-breaking materials from substrate surface and remove loose debris. Apply linear beads or spots of adhesive symmetrically to back of sign and of suitable quantity to support weight of sign after cure without slippage. Keep adhesive away from edges to prevent adhesive extrusion as sign is applied and to prevent visibility of cured adhesive at sign edges. Place sign in position, and push to engage adhesive. Temporarily support sign in position until adhesive fully sets.
 6. Two-Face Tape: Clean bond-breaking materials from substrate surface and remove loose debris. Apply tape strips symmetrically to back of sign and of suitable quantity to support weight of sign without slippage. Keep strips away from edges to prevent visibility at sign edges. Place sign in position, and push to engage tape adhesive.
 7. Hook-and-Loop Tape: Clean bond-breaking materials from substrate surface and remove loose debris. Apply sign component of two-part tape strips symmetrically to back of sign and of suitable quantity to support weight of sign without slippage; push to engage tape adhesive. Keep tape strips **0.250 inch** **<Insert dimension>** away from edges to prevent visibility at sign edges when sign is initially installed or reinstalled. Apply substrate component of tape to substrate in locations aligning with tape on back of sign; push and rub well to fully engage tape adhesive to substrate.
 8. Magnetic Tape: Clean bond-breaking materials from substrate surface and remove loose debris. Apply tape strips symmetrically to back of sign and of suitable quantity to support weight of sign without slippage. Keep strips away from edges to prevent visibility at sign edges. Place sign in position.
 9. Shim-Plate Mounting: Provide **1/8-inch**- thick, concealed aluminum shim plates with predrilled and countersunk holes, at locations indicated, and where other direct mounting methods are impractical. Attach plate with fasteners and anchors suitable for secure attachment to substrate. Attach signs to plate using **<Insert mounting method>** method specified above.
- D. Field-Applied, Vinyl-Character Signs: Clean and dry substrate. Align sign characters in final position before removing release liner. Remove release liner in stages, and apply and firmly press characters into final position. Press from the middle outward to obtain good bond without blisters or fishmouths. Remove carrier film without disturbing applied vinyl film.
- E. Signs Mounted on Glass: Provide opaque sheet matching sign material and finish onto opposite side of glass to conceal back of sign.

3.03 ADJUSTING AND CLEANING

- A. Remove and replace damaged or deformed signs and signs that do not comply with specified requirements. Replace signs with damaged or deteriorated finishes or components that cannot be successfully repaired by finish touchup or similar minor repair procedures.
- B. Remove temporary protective coverings and strippable films as signs are installed.
- C. On completion of installation, clean exposed surfaces of signs according to manufacturer's written instructions, and touch up minor nicks and abrasions in finish. Maintain signs in a clean condition during construction and protect from damage until acceptance by Owner.

END OF SECTION 10 14 23

SECTION 10 14 53**TRAFFIC SIGNS****PART I - GENERAL****1.1 SUMMARY****A. Description**

1. This Work includes the furnishing and installation of new signs, sign posts, parking meter posts, foundations and associated materials as shown on the Design Drawings, Chapter 3 of the Kansas City Traffic Operations Manual and specified herein. It includes the removal of existing signs as shown on the Design Drawings and as specified herein.
2. Traffic signs shall conform to KCMO requirements, the Missouri (MO) Standard Specification for Highway Construction, Division 900, and the Manual on Uniform Traffic Control Devices (MUTCD), except as modified herein and specified on the Design Drawings. Specifications shall apply based upon ownership of the roadway. If there is a conflict, the more stringent specification will apply.
3. Existing traffic signs shall be removed and salvaged in accordance with the requirements Chapter 3 of the Kansas City Traffic Operations Manual, except as modified herein and specified on the Design Drawings.

1.2 REFERENCES

<u>Sponsor</u>	<u>Number</u>	<u>Subject</u>
FHWA		Manual on Uniform Traffic Control Devices (MUTCD)
MoDOT	900	Missouri Standard Specifications Book for Highway Construction (2011), including General Provisions and Supplemental Specifications to the 2011 Missouri Standard Specifications for Highway Construction.
MoDOT	900	Standard Plans for Highway Construction – Traffic Control Devices

1.3 SUBMITTALS AND INFORMATION TO BE RETAINED

- A. Submittals shall be made in accordance with the requirements of the Project Quality Plan, except as modified herein.
- B. Retain the following in accordance with KCMO's General Conditions.
 1. Final Signing Design and layout.
 2. A certificate of compliance with specifications, detailed shop drawings, and wiring diagrams for the blankout signs and accessories.
 3. All manufacturer's warranties, guarantees, instruction sheets and parts lists.

1.4 QUALITY ASSURANCE/QUALITY CONTROL

Quality control shall be in accordance with the requirements of the Project Quality Plan, except as modified herein.

1.5 DELIVERY HANDLING AND STORAGE

Materials shall be delivered to the site in undamaged condition and stored off the ground in a well-drained location protected from damage, easily accessible for inspection and handling. Reflective services shall not be allowed to come in contact with dirt, water or debris.

PART II - PRODUCTS

2.1 MATERIALS

A. All signs, sign posts, foundations and associated materials shall be furnished by the Contractor.

B. Sign Face and Sign Legend Materials

1. All signs, markers and delineators shall be fabricated with using ASTM reflective sign sheeting Type IX or Type XI, except as specified below:
2. Sign face material for all warning signs, yellow markers, yellow delineators, shall be fluorescent yellow in color using ASTM sign sheeting Type IX or Type XI reflective sheeting. Type IX or XI sheeting shall be warranted for a minimum of seven (7) years.
3. Splicing of reflective sheeting shall not be permitted on signs or panels with dimensions up to and including 48 inches in height or width. All sheeting joints shall be vertical, and the fabricator shall use the least number of seams possible. Roller applied or reverse screened sheeting may be butt-jointed with a gap not to exceed 1/32 inch. Color matching of adjacent sheets of reflective sheeting comprising a sign shall be accomplished without a noticeable difference in color. No borders shall be spliced other than the splice of the tangent border to the corner radius. EC film shall never be spliced.
4. The City will require the manufacturer's warranty to cover the loss of retroreflectivity, colorfastness, cracking and other conditions inherent to the sheeting, including inks and overlay film that causes ineffectiveness in meeting the intended use.

If the sheeting color does not meet the color specifications of ASTM D 4956-09, Table 11 during the warranty period, the City will consider the sheeting to have lost colorfastness.

Submit applicable warranties for retroreflective sheeting to the Department. Ensure that the City of Kansas City is named the obligee on manufacturer warranties.

Retroreflective sheeting shall maintain a minimum of 70% of the factory retroreflectivity value during the warranty period.

C. Traffic signs, sign posts, foundations and associated materials shall conform to KCMO requirements, and MO Specification Division 900, Section 903, and the Design Drawings.

1. All signposts on the project shall be 10-foot long, 2-3/8" diameter, 16-gauge steel posts. A breakaway feature is NOT required.
2. All sign posts shall have a domed galvanized pole cap affixed to the top of the post.
3. All signposts, clamp brackets and post caps shall have a black powder coat finish.

D. Blankout (Interactive) Signs – A real time interactive sign stating "Train Coming", Turn Prohibition or other appropriate message when activated, and blank when not activated, shall be placed where warranted, including but not limited to:

1. Train and vehicles share the same physical space, for example a shared left turn lane.
2. Vehicles will cross the train track for a turning movement.
3. Driveway egress point which crosses Streetcar transit without protection.
4. Unsignalized or stop controlled intersections.
5. In combination with pedestrian signals if Streetcar station is to be used as a refuge.
6. Any signal controlled movement that is activated by a Streetcar vehicle.

These signs shall be activated prior to the arrival of a train.

PART III - EXECUTION

3.1 SIGN INSTALLATION

- A. Traffic signs shall be furnished and installed in accordance with KCMO requirements, the MO Specifications, Division 900, and the MUTCD, except as modified herein and specified on the Design Drawings.
- B. The Contractor shall mark on the Site the location for the proposed signs shown on the Design Drawings and shall conduct a Construction Design Review prior to installation. The Contractor shall not install any signs without written statement of no objection from the Engineer.
- C. The Contractor shall coordinate with KCMO 30 days prior to the installation of signs on the traffic signal mast-arms.
- D. The Contractor shall install signs as indicated on the Design Drawings.
- E. A 3/4" stainless steel band with a 12-gauge insert plate shall be used to place signs on OCS, signal or lighting standards. This plate shall be painted with a semi-gloss black paint when affixed to standards that are also painted black.
- F. Signs shall be covered securely with a durable material if erected before stated condition exists.
- G. A fabrication sticker shall be provided and affixed on back side of each new sign panel by the sign fabricator. On rectangular panels the sticker shall be placed on the lower right hand corner of the panel. On diamond-shaped panels the sticker shall be placed on the right corner of the panel.

1. The sticker shall contain the Fabricator's name and address, the twelve months of the year, and the current and following 4 years (last two digits of each year).
2. The month and year of fabrication may be indicated either by punching out the appropriate month and year prior to placement on the panel or by blocking out the appropriate month and year on the screen prior to applying the black ink so that the month and year of fabrication will not be displayed.

3.2 OVERHEAD CONTACT SYSTEM (OCS) POLE ISLAND

- A. The Contractor shall place 3" x 6" self adhesive yellow reflective Type IX or XI sheeting on a 3" x 6" x 1/8" thick aluminum plate and adhere the plate to the OCS island with an outside adhesive.

3.3 REMOVAL AND SALVAGE OF EXISTING SIGNS

- A. Existing traffic signs shall be removed and salvaged in accordance with the requirements of the MO Specifications, Division 900, except as modified herein. The Contractor shall verify ownership of signs, and salvage and return signs to the respective owner per their specification.
- B. Existing signs that will conflict with the regulation of traffic and parking through construction and final configuration shall be removed or covered until the sign is again valid.
- C. For all signs being removed or salvaged, the Contractor shall remove all existing bracketing and mounting hardware. New bracketing and mounting hardware shall be utilized when reinstalling a salvaged sign panel.

3.4 SIGN REPLACEMENT

The Contractor shall utilize new bracketing and mounting hardware when reinstalling a salvaged sign panel.

END OF SECTION

SECTION 10 21 13**SOLID-POLYMER TOILET COMPARTMENTS****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section Includes solid-polymer toilet compartments configured as toilet enclosures and urinal screens.
- B. Related Sections:
 - 1. Section 10 28 00 "Toilet, Bath, and Laundry Accessories" for toilet tissue dispensers, grab bars, purse shelves, and similar accessories.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
- B. Shop Drawings: For toilet compartments. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Show locations of cutouts for compartment-mounted toilet accessories.
 - 2. Show locations of reinforcements for compartment-mounted grab bars.
 - 3. Show locations of centerlines of toilet fixtures.
- C. Samples for Initial Selection: For each type of unit indicated. Include Samples of hardware and accessories involving material and color selection.
- D. Samples for Verification: For the following products, in manufacturer's standard sizes unless otherwise indicated:
 - 1. Each type of material, color, and finish required for units, prepared on 6-inch-square Samples of same thickness and material indicated for Work.
 - 2. Each type of hardware and accessory.

1.04 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of toilet compartment, from manufacturer.

1.05 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For toilet compartments to include in maintenance manuals.

1.06 QUALITY ASSURANCE

- A. Comply with requirements in GSA's CID-A-A-60003, "Partitions, Toilets, Complete."
- B. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84, or another standard acceptable to authorities having

jurisdiction, by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: 25 or less.
2. Smoke-Developed Index: 450 or less.

- C. Regulatory Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA) and Architectural Barriers Act (ABA) Accessibility Guidelines for Buildings and Facilities" and ICC/ANSI A117.1 for toilet compartments designated as accessible.

1.07 PROJECT CONDITIONS

- A. Field Measurements: Verify actual locations of toilet fixtures, walls, columns, ceilings, and other construction contiguous with toilet compartments by field measurements before fabrication.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Aluminum Castings: ASTM B 26/B 26M.
- B. Aluminum Extrusions: [ASTM B 221](#).
- C. Brass Castings: ASTM B 584.
- D. Brass Extrusions: ASTM B 455.
- E. Steel Sheet: Commercial steel sheet for exposed applications; mill phosphatized and selected for smoothness.
1. Electrolytically Zinc Coated: ASTM A 879/A 879M, [01Z](#).
 2. Hot-Dip Galvanized: ASTM A 653/A 653M, either hot-dip galvanized or galvanized.
- F. Stainless-Steel Sheet: ASTM A 666, Type 304, stretcher-leveled standard of flatness.
- G. Stainless-Steel Castings: ASTM A 743/A 743M.
- H. Zamac: ASTM B 86, commercial zinc-alloy die castings.
- I. Adhesives: Manufacturer's standard product that complies with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.02 SOLID-POLYMER UNITS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide solid polymer toilet partitions by Hadrian Manufacturing Inc.
- A. Toilet-Enclosure Style: Overhead braced.
- B. Urinal-Screen Style: Wall hung flat panel.
- C. Door, Panel, Screen, and Pilaster Construction: Solid, high-density polyethylene

(HDPE panel material, not less than 1 inch thick, seamless, with eased edges and with homogenous color and pattern throughout thickness of material.

1. Integral Hinges: Configure doors and pilasters to receive integral hinges.
 2. Color and Pattern: as selected by Architect from manufacturer's full range.
- D. Pilaster Shoes and Sleeves (Caps): Manufacturer's standard design; polymer or stainless steel.
1. Polymer Color and Pattern: Matching pilaster.
- E. Urinal-Screen Post: Manufacturer's standard post design of 1-3/4-inch- square, aluminum tube with satin finish; with shoe and sleeve (cap) matching that on the pilaster.
- F. Brackets (Fittings):
1. Stirrup Type: Ear or U-brackets, stainless steel.
 2. Full-Height (Continuous) Type: Manufacturer's standard design; polymer or extruded aluminum.
 - a. Polymer Color and Pattern: Matching panel.

1.02 ACCESSORIES

- A. Hardware and Accessories: Manufacturer's standard design, heavy-duty operating hardware and accessories.
1. Material: Stainless steel.
 2. Hinges: Manufacturer's standard paired, self-closing type that can be adjusted to hold doors open at any angle up to 90 degrees.
 3. Latch and Keeper: Manufacturer's standard surface-mounted latch unit designed for emergency access and with combination rubber-faced door strike and keeper. Provide units that comply with regulatory requirements for accessibility at compartments designated as accessible.
 4. Coat Hook: Manufacturer's standard combination hook and rubber-tipped bumper, sized to prevent in-swinging door from hitting compartment-mounted accessories.
 5. Door Bumper: Manufacturer's standard rubber-tipped bumper at out-swinging doors.
 6. Door Pull: Manufacturer's standard unit at out-swinging doors that complies with regulatory requirements for accessibility. Provide units on both sides of doors at compartments designated as accessible.
- B. Overhead Bracing: Manufacturer's standard continuous, extruded-aluminum head rail with antigrip profile and in manufacturer's standard finish.
- C. Anchorages and Fasteners: Manufacturer's standard exposed fasteners of stainless steel or chrome-plated steel or brass, finished to match the items they are securing, with theft-resistant-type heads. Provide sex-type bolts for through-bolt applications. For concealed anchors, use stainless steel, hot-dip galvanized steel, or other rust-resistant, protective-coated steel.

1.03 FABRICATION

- A. Overhead-Braced Units: Provide manufacturer's standard corrosion-resistant supports, leveling mechanism, and anchors at pilasters to suit floor conditions. Provide shoes at pilasters to conceal supports and leveling mechanism.

- B. Urinal-Screen Posts: Provide manufacturer's standard corrosion-resistant anchoring assemblies with leveling adjustment at bottoms of posts. Provide shoes and sleeves (caps) at posts to conceal anchorage.
- C. Door Size and Swings: Unless otherwise indicated, provide 24-inch- wide, in-swinging doors for standard toilet compartments and 36-inch- wide, out-swinging doors with a minimum 32-inch- wide, clear opening for compartments designated as accessible.

PART 2 - EXECUTION

2.01 INSTALLATION

- A. General: Comply with manufacturer's written installation instructions. Install units rigid, straight, level, and plumb. Secure units in position with manufacturer's recommended anchoring devices.
 - 1. Maximum Clearances:
 - a. Pilasters and Panels: 1/2 inch.
 - b. Panels and Walls: 1 inch.
 - 2. Stirrup Brackets: Secure panels to walls and to pilasters with no fewer than three brackets attached at midpoint and near top and bottom of panel.
 - a. Locate wall brackets so holes for wall anchors occur in masonry or tile joints.
 - b. Align brackets at pilasters with brackets at walls.
- B. Overhead-Braced Units: Secure pilasters to floor and level, plumb, and tighten. Set pilasters with anchors penetrating not less than 1-3/4 inches into structural floor unless otherwise indicated in manufacturer's written instructions. Secure continuous head rail to each pilaster with no fewer than two fasteners. Hang doors to align tops of doors with tops of panels, and adjust so tops of doors are parallel with overhead brace when doors are in closed position.
- C. Urinal Screens: Attach with anchoring devices to suit supporting structure. Set units level and plumb, rigid, and secured to resist lateral impact.

2.02 ADJUSTING

- A. Hardware Adjustment: Adjust and lubricate hardware according to hardware manufacturer's written instructions for proper operation. Set hinges on in-swinging doors to hold doors open approximately 30 degrees from closed position when unlatched. Set hinges on out-swinging doors to return doors to fully closed position.

END OF SECTION 10 21 13

SECTION 10 26 13**STAINLESS STEEL CORNER GUARDS****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. This Section includes stainless steel corner guards.

1.03 SUBMITTALS

- A. Product data.
- B. Shop Drawings: Show locations, extent, and installation details of each corner guard component. Show methods of attachment to adjoining construction.
- C. Samples for Verification: For the following products, showing the full range of finish variations expected in each corner guard component. Prepare Samples from the same material to be used for the Work.
 - 1. Wall and Corner Guards: 12-inch- long Samples of each type of corner guard component required.

1.04 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who has completed installation of corner guard components similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.
- B. Manufacturer Qualifications: A firm experienced in manufacturing corner guard components similar to those required for this Project and with a record of successful in-service performance.
- C. Source Limitations: Obtain each finish, and type of corner guard component from a single source with resources to provide components of consistent quality in appearance and physical properties.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Store corner guards in original undamaged packages and containers inside a well-ventilated area protected from weather, moisture, soiling, extreme temperatures, and humidity.

1.06 PROJECT CONDITIONS

- A. Environmental Limitations: Do not install corner guard components until the space is enclosed and weatherproof and ambient temperature within the building is maintained at not less than 70 deg F for not less than 72 hours before beginning installation.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering corner guard products that may be incorporated into the Work include, but are not limited to, the following:
1. Balco, Inc.
 2. Construction Specialties, Inc.
 3. IPC Door and Wall Protection Systems, Inc.
 4. Pawling Corporation.

2.02 MATERIALS

- A. Stainless-Steel Plate: Type 304, minimum 0.0625 inch.
- B. Fasteners: Provide nonmagnetic stainless-steel metal screws, bolts, and other fasteners. Use theftproof fasteners where exposed to view.

2.03 CORNER GUARDS

- A. Stainless-Steel Corner Guards: Paper-covered, satin-finish, 0.0625-inch minimum, stainless-steel sheet corner guards. Provide 90-degree turn, unless otherwise indicated; and formed edges.
1. Wing Size: 4-1/2 by 4-1/2 inches.
 2. Mounting Method: Countersunk screws with mounting holes 8 inches o.c.
 3. Corner Radius: 1/8 inch.
 4. Height: 4-feet unless indicated otherwise.

2.04 FABRICATION

- A. General: Fabricate corner guards to comply with requirements indicated for design, dimensions, details, finish, and member sizes, including thicknesses of components.
- B. Provide surfaces free of wrinkles, chips, dents, uneven coloration, and other imperfections.
- C. Anchors: Provide wall anchors for connecting corner guards to other construction.
- D. Provide inserts and other anchoring devices for connecting components to concrete or masonry. Fabricate anchoring devices to withstand imposed loads. Coordinate anchoring devices with the supporting structure.

2.05 FINISHES, GENERAL

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary covering before shipping.

2.06 STAINLESS-STEEL FINISHES

- A. Finish: Directional satin, No. 6 Bright annealed.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine areas and conditions in which corner guard components will be installed.
 - 1. Complete finishing operations, including painting, before installing corner guard components.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. General: Before installation, clean substrate to remove dust, debris, and loose particles.

3.03 INSTALLATION

- A. Install corner guard components level, plumb, and true to line without distortions.
 - 1. Do not use materials with stains or other defects that might be visible in the finished Work.

3.04 CLEANING

- A. General: Clean metal components according to the manufacturer's written instructions.
- B. Remove surplus materials, rubbish, and debris, resulting from installation, on completion of work and leave installation areas in neat, clean condition.

END OF SECTION 10 26 13

SECTION 10 28 13**COMMERCIAL TOILET ACCESSORIES****PART 1 - GENERAL****1.01 SUMMARY****A. Section Includes:**

1. Public-use washroom accessories.
2. Under lavatory guards.

B. Related Sections:

1. Section 08 83 00 "Mirrors" for frameless mirrors.
2. Section 09 30 00 "Tiling" for ceramic toilet and bath accessories.

1.02 SUBMITTALS**A. Product Data:** For each type of product indicated. Include the following:

1. Construction details and dimensions.
2. Anchoring and mounting requirements, including requirements for cutouts in other work and substrate preparation.
3. Material and finish descriptions.
4. Features that will be included for Project.
5. Manufacturer's warranty.

B. Samples: Full size, for each accessory item to verify design, operation, and finish requirements.

1. Approved full-size Samples will be returned and may be used in the Work.

C. Product Schedule: Indicating types, quantities, sizes, and installation locations by room of each accessory required.

1. Identify locations using room designations indicated.
2. Identify products using designations indicated.

D. Warranty: Sample of special warranty.**E. Maintenance Data:** For toilet and bath accessories to include in maintenance manuals.**1.03 QUALITY ASSURANCE****A. Source Limitations:** For products listed together in the same Part 2 articles, obtain products from single source from single manufacturer.**B. Electrical Components, Devices, and Accessories:** Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.**1.04 COORDINATION****A. Coordinate** accessory locations with other work to prevent interference with clearances required for access by people with disabilities, and for proper

installation, adjustment, operation, cleaning, and servicing of accessories.

- B. Deliver inserts and anchoring devices set into concrete or masonry as required to prevent delaying the Work.

1.05 WARRANTY

- A. Special Mirror Warranty: Manufacturer's standard form in which manufacturer agrees to replace mirrors that develop visible silver spoilage defects and that fail in materials or workmanship within specified warranty period.

1. Warranty Period: 15 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Basis of Design: Subject to requirements, provide accessories by the following:

1. Toilet and Bath Accessories: Bobrick.
2. Underlavatory Guards: Truebro, Inc.

- B. Products: Subject to compliance with requirements, provide one of the products indicated for each designation in the Toilet and Bath Accessory Schedule at the end of Part 3.

2.02 MATERIALS

- A. Stainless Steel: ASTM A 666, Type 304, with No. 4 finish (satin), in 0.0312-inch minimum nominal thickness, unless otherwise indicated.
- B. Brass: ASTM B 19, leaded and unleaded flat products; ASTM B 16, rods, shapes, forgings, and flat products with finished edges; ASTM B 30, castings.
- C. Sheet Steel: ASTM A 366/A 366M, cold rolled, commercial quality, 0.0359-inch minimum nominal thickness; surface preparation and metal pretreatment as required for applied finish.
- D. Galvanized Steel Sheet: ASTM A 653/A 653M, G60.
- E. Galvanized Steel Mounting Devices: ASTM A 153/A 153M, hot-dip galvanized after fabrication.
- F. Fasteners: Screws, bolts, and other devices of same material as accessory unit, tamper and theft resistant when exposed, and of galvanized steel when concealed.

2.03 FABRICATION

- A. General: Names or labels are not permitted on exposed faces of accessories. On interior surface not exposed to view or on back surface of each accessory, provide printed, waterproof label or stamped nameplate indicating manufacturer's name and product model number.
- B. Recessed Toilet Accessories: Unless otherwise indicated, fabricate units of all-welded construction, without mitered corners. Hang doors and access panels with full-length, stainless-steel hinge. Provide anchorage that is fully concealed when

unit is closed.

- C. Keys: Provide universal keys for internal access to accessories for servicing and resupplying. Provide minimum of six keys to Authority's representative.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install accessories according to manufacturers' written instructions, using fasteners appropriate to substrate indicated and recommended by unit manufacturer. Install units level, plumb, and firmly anchored in locations and at heights indicated.
- B. Install grab bars to withstand a downward load of at least 250 lbf, when tested according to method in ASTM F 446.

3.02 ADJUSTING AND CLEANING

- A. Adjust accessories for unencumbered, smooth operation and verify that mechanisms function properly. Replace damaged or defective items.
- B. Remove temporary labels and protective coatings.
- C. Clean and polish exposed surfaces according to manufacturer's written recommendations.

3.03 TOILET AND BATH ACCESSORY SCHEDULE

- | | |
|--|-----------------|
| A. Recessed convertible paper towel dispenser and waste receptacle | Bobrick B-43944 |
| B. Automatic lavatory-mounted soap dispenser | Bobrick B-826 |
| C. Surface-mounted soap dispenser | Bobrick B-4112 |
| D. Reversible solid phenolic folding shower seat | Bobrick B-5181 |
| E. Recessed seat-cover dispenser, sanitary napkin disposal and toilet tissue dispenser | Bobrick B-3574 |
| F. Recessed seat-cover dispenser, sanitary napkin disposal and toilet tissue dispenser | Bobrick B-3574 |
| G. Partition-mounted seat-cover dispenser, sanitary napkin disposal, and toilet tissue dispenser | Bobrick B-3571 |
| H. Surface-mounted seat-cover and toilet tissue dispenser | Bobrick B-3479 |
| I. Extra-heavy-duty shower curtain rod | Bobrick B-6074 |
| J. Stainless steel shower curtain hook | Bobrick 204-1 |
| K. Vinyl shower curtain | Bobrick 204-2 |
| L. Glass mirror with stainless steel angle frame | Bobrick B-290 |

M. Utility shelf with mop/broom holders and rag hooks	Bobrick B-239
N. Heavy-duty clothes hook with concealed mounting hooks	Bobrick B-2116
O. Folding utility shelf	Bobrick B-287
P. Folding Utility Shelf	Bobrick B-287
Q. 18"-1 ½" diameter stainless steel grab bars with snap flange	Bobrick B-6806
R. 36"-1 ½" diameter stainless steel grab bars with snap flange	Bobrick B-6806
S. 42"-1 ½" diameter stainless steel grab bars with snap flange	Bobrick B-6806
T. Two-wall shower/tub compartment grab bar	Bobrick B-68616.99
U. Surface-mounted seat-cover dispenser	Bobrick B-4221
V. Surface-mounted sanitary napkin disposal	Bobrick B-254
W. Surface-mounted sanitary napkin disposal	Bobrick B-270
X. Partition-mounted dual-sided multi-roll toilet tissue dispenser	Bobrick B-386
Y. Recessed sanitary napkin disposal and toilet tissue dispenser	Bobrick B-3094
Z. Recessed multi-roll toilet tissue dispenser	Bobrick B-4388
AA. Surface-mounted multi-roll toilet tissue dispenser	Bobrick B-4288
AB. Interchangeable receptacle	Bobrick 368-60
AC. Under-lavatory guards	Lav Guard2
AD. Convertible universal roll paper towel module	Bobrick 3974-50

END OF SECTION 10 28 13

SECTION 10 41 16**FIRE DEPARTMENT KEY BOX****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. This Section includes recessed Fire Department key storage box ("knox box").
- B. Related Sections: The following Sections contain requirements that may relate to this Section:
 - 1. Division 7 Section "Joint Sealants" for sealant applied to joint between key box and mounting substrate.

1.03 SUBMITTALS

- A. Product Data: For each type of product indicated.

1.04 COORDINATION

- A. Coordinate installation of anchorages and recessed mount for key storage box. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.
- B. Key Storage Box: Locate boxes where indicated on Drawings and position as required by local Fire Department.

PART 2 - PRODUCTS**2.01 FIRE DEPARTMENT KEY STORAGE BOX**

- A. General: Heavy-duty, UL Rated, high-security, factory finish metal box designed to store keys for Fire Department access.
- B. Basis of Design Product: Subject to compliance with the requirements provide Knox Company; Knox Box 3200 Series or comparable product by another manufacturer acceptable to Authorities Having Jurisdiction.
 - 1. Mounting: Recessed mounted.
 - 2. Size: Approximately 5-inches high by 4-inches wide by 3-1/4-inches deep.
 - 3. Door Type: Lift-off.
 - 4. Color. Black.

2.02 ACCESSORIES

- A. Recessed Mounting Kit: Steel box assembly with integral box mounting bolts and concrete or masonry anchors, designed to recess storage box. Provide only kits supplied by manufacturer of storage box.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, critical dimensions, and other conditions affecting performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Recessed Mounting: Incorporate recessed mounting kit into masonry or concrete wall during wall construction. Install key box in recessed mount after walls are substantially completed and cleaned.
- B. Apply elastomeric sealant to top and side joints between key box and mounting substrate in accordance with requirements of Section 07920 Joint Sealants. Leave bottom joint open for drainage.

3.03 ADJUSTING AND CLEANING

- A. Confirm that box doors engage accurately and securely without forcing or binding.
- B. After completing installation of exposed, factory-finished boxes, inspect exposed finishes and repair damaged finishes.

END OF SECTION 10 41 16

SECTION 10 44 13**PORTABLE FIRE EXTINGUISHER CABINETS****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section Includes fire protection cabinets for portable fire extinguishers.
- B. Related Sections:
 - 1. Section 09 91 13 "Exterior Painting" for field painting fire protection cabinets.
 - 2. Section 10 14 00 "Signage" for directional signage to out-of-sight fire extinguishers and cabinets.
 - 3. Section 10 44 16 "Portable Multipurpose Dry-Chemical Fire Extinguishers."
 - 4. Section 26 51 00 "Interior Lighting" for fire extinguisher location lights.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for fire protection cabinets.
 - 1. Fire Protection Cabinets: Include roughing-in dimensions, details showing mounting methods, relationships of box and trim to surrounding construction, door hardware, cabinet type, trim style, and panel style.
- B. Shop Drawings: For fire protection cabinets. Include plans, elevations, sections, details, and attachments to other work.
- C. Samples for Initial Selection: For each type of fire protection cabinet indicated.
- D. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below:
 - 1. Size: **6 by 6 inches** square.
- E. Product Schedule: For fire protection cabinets. Coordinate final fire protection cabinet schedule with fire extinguisher schedule to ensure proper fit and function.

1.04 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For fire protection cabinets to include in maintenance manuals.

1.05 QUALITY ASSURANCE

- A. Fire-Rated, Fire Protection Cabinets: Listed and labeled to comply with requirements in ASTM E 814 for fire-resistance rating of walls where they are installed.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and

application.

1.06 COORDINATION

- A. Coordinate size of fire protection cabinets to ensure that type and capacity of fire extinguishers indicated are accommodated.
- B. Coordinate sizes and locations of fire protection cabinets with wall depths.

1.07 SEQUENCING

- A. Apply vinyl lettering on field-painted, fire protection cabinets after painting is complete.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B.
- B. Aluminum: Alloy and temper recommended by aluminum producer and manufacturer for type of use and finish indicated, and as follows:
 - 1. Sheet: [ASTM B 209](#).
 - 2. Extruded Shapes: [ASTM B 221](#).
- C. Clear Float Glass: ASTM C 1036, Type I, Class 1, Quality q3, 3 mm thick.

2.02 FIRE PROTECTION CABINET

- A. Cabinet Type: Suitable for fire extinguisher.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Fire End & Croker Corporation;
 - b. J. L. Industries, Inc., a division of Activar Construction Products Group;
 - c. Kidde Residential and Commercial Division, Subsidiary of Kidde plc;
 - d. Larsen's Manufacturing Company;
 - e. Modern Metal Products, Division of Technico Inc.;
 - f. Moon-American;
 - g. Potter Roemer LLC;
 - h. Watrous Division, American Specialties, Inc.;
- B. Cabinet Construction: Nonrated.
- C. Cabinet Material: Steel sheet.
- D. Recessed Cabinet: Cabinet box recessed in walls of sufficient depth to suit style of trim indicated.
 - 1. Trimless with Concealed Flange: Surface of surrounding wall finishes flush with exterior finished surface of cabinet frame and door, without overlapping trim

attached to cabinet. Provide recessed flange, of same material as box, attached to box to act as drywall bead.

- E. Semirecessed Cabinet: Cabinet box partially recessed in walls of sufficient depth to suit style of trim indicated; with one-piece combination trim and perimeter door frame overlapping surrounding wall surface with exposed trim face and wall return at outer edge (backbend). Provide where walls are of insufficient depth for recessed cabinets but are of sufficient depth to accommodate semirecessed cabinet installation.
 - 1. Square-Edge Trim: 1-1/4- to 1-1/2-inch backbend depth.
- F. Cabinet Trim Material: Same material and finish as door.
- G. Door Material: Aluminum sheet.
- H. Door Style: Fully glazed panel with frame.
- I. Door Glazing: Clear float glass.
- J. Door Hardware: Manufacturer's standard door-operating hardware of proper type for cabinet type, trim style, and door material and style indicated.
 - 1. Provide manufacturer's standard.
 - 2. Provide manufacturer's standard hinge permitting door to open 180 degrees.
- K. Accessories:
 - 1. Mounting Bracket: Manufacturer's standard steel, designed to secure fire extinguisher to fire protection cabinet, of sizes required for types and capacities of fire extinguishers indicated, with plated or baked-enamel finish.
 - 2. Break-Glass Strike: Manufacturer's standard metal strike, complete with chain and mounting clip, secured to cabinet.
 - 3. Lettered Door Handle: One-piece, cast-iron door handle with the word "FIRE" embossed into face.
 - 4. Door Lock: Cam lock that allows door to be opened during emergency by pulling sharply on door handle.
 - 5. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as directed by Architect.
 - a. Identify fire extinguisher in fire protection cabinet with the words "FIRE EXTINGUISHER."
 - 1) Location: Applied to cabinet glazing.
 - 2) Application Process: Pressure-sensitive vinyl letters.
 - 3) Lettering Color: Red.
 - 4) Orientation: Vertical.
 - 6. Alarm: Manufacturer's standard alarm that actuates when fire protection cabinet door is opened and that is powered by low voltage, complete with transformer.
- L. Finishes:
 - 1. Aluminum: Baked enamel or powder coat.

2.03 FABRICATION

- A. Fire Protection Cabinets: Provide manufacturer's standard box (tub) with trim, frame, door, and hardware to suit cabinet type, trim style, and door style indicated.

1. Weld joints and grind smooth.
 2. Provide factory-drilled mounting holes.
 3. Prepare doors and frames to receive locks.
 4. Install door locks at factory.
- B. Cabinet Doors: Fabricate doors according to manufacturer's standards, from materials indicated and coordinated with cabinet types and trim styles selected.
1. Fabricate door frames with tubular stiles and rails and hollow-metal design, minimum **1/2 inch** thick.
 2. Fabricate door frames of one-piece construction with edges flanged.
 3. Miter and weld perimeter door frames.
- C. Cabinet Trim: Fabricate cabinet trim in one piece with corners mitered, welded, and ground smooth.

2.04 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces of fire protection cabinets from damage by applying a strippable, temporary protective covering before shipping.
- C. Finish fire protection cabinets after assembly.
- D. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.05 ALUMINUM FINISHES

- A. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of **1.5 mils**. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
1. Color and Gloss: As selected by Architect from manufacturer's full range.

2.06 STEEL FINISHES

- A. Baked-Enamel or Powder-Coat Finish: Immediately after cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat. Comply with coating manufacturer's written instructions for applying and baking to achieve a minimum dry film thickness of **2 mils**.
1. Color and Gloss: As selected by Architect from manufacturer's full range.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine walls and partitions for suitable framing depth and blocking where recessed and semirecessed cabinets will be installed.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Prepare recesses for recessed and semirecessed fire protection cabinets as required by type and size of cabinet and trim style.

3.03 INSTALLATION

- A. General: Install fire protection cabinets in locations and at mounting heights indicated
- B. Fire Protection Cabinets: Fasten cabinets to structure, square and plumb.
 - 1. Unless otherwise indicated, provide recessed fire protection cabinets. If wall thickness is not adequate for recessed cabinets, provide semirecessed fire protection cabinets.
 - 2. Provide inside latch and lock for break-glass panels.
 - 3. Fasten mounting brackets to inside surface of fire protection cabinets, square and plumb.
- C. Identification: Apply vinyl lettering at locations indicated.

3.04 ADJUSTING AND CLEANING

- A. Remove temporary protective coverings and strippable films, if any, as fire protection cabinets are installed unless otherwise indicated in manufacturer's written installation instructions.
- B. Adjust fire protection cabinet doors to operate easily without binding. Verify that integral locking devices operate properly.
- C. On completion of fire protection cabinet installation, clean interior and exterior surfaces as recommended by manufacturer.
- D. Touch up marred finishes, or replace fire protection cabinets that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by fire protection cabinet and mounting bracket manufacturers.
- E. Replace fire protection cabinets that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 10 44 13

SECTION 10 44 16**PORTABLE MULTIPURPOSE DRY-CHEMICAL FIRE EXTINGUISHERS****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section includes portable, hand-carried, multipurpose dry-chemical in container type fire extinguishers and mounting brackets for fire extinguishers.
- B. Related Sections:
 - 1. Section 10 44 13 "Fire Extinguisher Cabinets."

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include rating and classification, material descriptions, dimensions of individual components and profiles, and finishes for fire extinguisher and mounting brackets.
- B. Product Schedule: For fire extinguishers. Coordinate final fire extinguisher schedule with fire protection cabinet schedule to ensure proper fit and function.

1.04 INFORMATIONAL SUBMITTALS

- A. Warranty: Sample of special warranty.

1.05 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fire extinguishers to include in maintenance manuals.

1.06 QUALITY ASSURANCE

- A. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."
- B. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.
 - 1. Provide fire extinguishers approved, listed, and labeled by FMG.

1.07 COORDINATION

- A. Coordinate type and capacity of fire extinguishers with fire protection cabinets to ensure fit and function.

1.08 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace fire extinguishers that fail in materials or workmanship within

specified warranty period.

1. Failures include, but are not limited to, the following:
 - a. Failure of hydrostatic test according to NFPA 10.
 - b. Faulty operation of valves or release levers.
2. Warranty Period: Six years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 PORTABLE, HAND-CARRIED FIRE EXTINGUISHERS

- A. Fire Extinguishers: Type, size, and capacity for each fire protection cabinet and mounting bracket indicated.
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Amerex Corporation.
 - b. J. L. Industries, Inc.; a division of Activar Construction Products Group.
 - c. Larsen's Manufacturing Company.
 - d. Potter Roemer LLC.
 2. Valves: Manufacturer's standard.
 3. Handles and Levers: Manufacturer's standard.
 4. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix B and bar coding for documenting fire extinguisher location, inspections, maintenance, and recharging.
- B. Multipurpose Dry-Chemical Type in Steel Container, Bracket Mounted: UL-rated 4-A:60-B:C, 10-lb nominal capacity, with monoammonium phosphate-based dry chemical in enameled-steel container.

2.02 MOUNTING BRACKETS

- A. Mounting Brackets for 10 lb. Fire Extinguishers: Manufacturer's standard steel, designed to secure fire extinguisher to wall or structure, of sizes required for types and capacities of fire extinguishers indicated, with plated or black baked-enamel finish.
 1. Manufacturers: Subject to compliance with requirements, provide products by same manufacturer supplying fire extinguishers.
- B. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as indicated by Architect.
 1. Identify bracket-mounted fire extinguishers with the words "FIRE EXTINGUISHER" in red letter decals applied to mounting surface.
 - a. Orientation: Vertical.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine fire extinguishers for proper charging and tagging.
 - 1. Remove and replace damaged, defective, or undercharged fire extinguishers.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. General: Install fire extinguishers and mounting brackets in locations indicated and in compliance with requirements of authorities having jurisdiction.
 - 1. Mounting Brackets: 54 inches above finished floor to top of fire extinguisher.
- B. Mounting Brackets: Fasten mounting brackets to surfaces, square and plumb, at locations indicated.

3.03 CLEANING

- A. Construction Waste Management and Disposal: Comply with Waste Management Plan required under Division 01 Section "Construction Waste Management And Disposal."

END OF SECTION 10 44 16

SECTION 10 51 13

STANDARD METAL LOCKERS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section Includes Standard metal lockers, knock-down type, and locker benches.

1.03 SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of metal locker.
- B. Shop Drawings: For metal lockers. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Show locker trim and accessories.
 - 2. Include locker identification system and numbering sequence.
- C. Samples for Initial Selection: For units with factory-applied color finishes.
- D. Samples for Verification: For metal lockers and locker benches in manufacturer's standard sizes.
- E. Qualification Data: For qualified Installer.
- F. Maintenance Data: For adjusting, repairing, and replacing locker doors and latching mechanisms to include in maintenance manuals.
- G. Warranty: Sample of special warranty.

1.04 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
- B. Source Limitations: Obtain metal lockers, locker benches and accessories from single source from single manufacturer.
- C. Regulatory Requirements: Provide lockers and locker benches that comply with the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA) and Architectural Barriers Act (ABA) Accessibility Guidelines for Buildings and Facilities".
- D. Preinstallation Conference: Conduct conference at Project site.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Do not deliver metal lockers until spaces to receive them are clean, dry, and ready for

their installation.

1.06 PROJECT CONDITIONS

- A. Field Measurements: Verify actual dimensions of recessed openings by field measurements before fabrication.

1.07 COORDINATION

- A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of work specified in other Sections to ensure that metal lockers can be supported and installed as indicated.

1.08 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal lockers that fail in materials or workmanship, excluding finish, within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures.
 - b. Faulty operation of latches and other door hardware.
 - 2. Damage from deliberate destruction and vandalism is excluded.
 - 3. Warranty Period for Knocked-Down Metal Lockers: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B, suitable for exposed applications.
- B. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B; with A60 zinc-iron, alloy (galvannealed) coating designation.
- C. Steel Tube: ASTM A 500, cold rolled.
- D. Fasteners: Zinc- or nickel-plated steel, slotless-type, exposed bolt heads; with self-locking nuts or lock washers for nuts on moving parts.
- E. Anchors: Material, type, and size required for secure anchorage to each substrate.
 - 1. Provide nonferrous-metal or hot-dip galvanized anchors and inserts for corrosion resistance.
 - 2. Provide toothed-steel or lead expansion sleeves for drilled-in-place anchors.

2.02 STANDARD METAL LOCKERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Penco Products, Inc.; Vanguard Lockers or comparable product by one of the following:
 - 1. Art Metal Products.
 - 2. ASI Storage Solutions Inc.
 - 3. DeBourgh Mfg. Co.

4. List Industries Inc.
 5. Lyon Workspace Products.
 6. Republic Storage Systems Company.
 7. Tennsco Corp.
- B. Locker Arrangement and Size: As indicated on Drawings.
- C. Material: Metallic-coated steel sheet.
- D. Body: Assembled by riveting or bolting body components together. Fabricate from unperforated steel sheet as follows:
1. Tops, Bottoms, and Intermediate Dividers: 0.024-inch nominal thickness, with single bend at sides.
 2. Backs and Sides: 0.024-inch nominal thickness, with full-height, double-flanged connections.
 3. Shelves: 0.024-inch nominal thickness, with double bend at front and single bend at sides and back. Two shelves in each locker, including one lower shelf for boots.
- E. Frames: Channel formed; fabricated from 0.060-inch nominal-thickness steel sheet; lapped and factory welded at corners; with top and bottom main frames factory welded into vertical main frames. Form continuous, integral door strike full height on vertical main frames.
- F. Doors: One piece; fabricated from 0.060-inch nominal-thickness steel sheet; formed into channel shape with double bend at vertical edges and with right-angle single bend at horizontal edges.
1. Doors less than 12 inches wide may be fabricated from 0.048-inch nominal-thickness steel sheet.
 2. Doors for box lockers less than 15 inches wide may be fabricated from 0.048-inch nominal-thickness steel sheet.
 3. Reinforcement: Manufacturer's standard reinforcing angles, channels, or stiffeners for doors more than 15 inches wide; welded to inner face of doors.
 4. Stiffeners: Manufacturer's standard full-height stiffener fabricated from 0.048-inch nominal-thickness steel sheet; welded to inner face of doors.
 5. Door Style: Vented panel as follows:
 - a. Louvered Vents: No fewer than six louver openings at top and bottom for single-tier lockers.
- G. Hinges: Welded to door and attached to door frame with no fewer than two factory-installed rivets per hinge that are completely concealed and tamper resistant when door is closed; fabricated to swing 180 degrees.
1. Knuckle Hinges: Steel, full loop, five or seven knuckles, tight pin; minimum 2 inches high. Provide no fewer than three hinges for each door more than 42 inches high.
- H. Projecting Door Handle and Latch: Finger-lift latch control designed for use with padlocks; positive automatic latching, chromium plated; pry and vandal resistant.
1. Latch Hooks: Equip doors 48 inches and higher with three latch hooks; fabricated from 0.105-inch nominal-thickness steel sheet; welded or riveted to full-height door strikes; with resilient silencer on each latch hook.

2. Latching Mechanism: Manufacturer's standard, rattle-free latching mechanism and moving components isolated to prevent metal-to-metal contact, and incorporating a prelocking device that allows locker door to be locked while door is open and then closed without unlocking or damaging lock or latching mechanism.
- I. Equipment: Equip each metal locker with identification plate, shelf, 3 single-prong wall hooks, and 1 coat rod, unless otherwise indicated on Drawings.
 - J. Accessories:
 1. Continuous Zee Base: Fabricated from manufacturer's standard thickness, but not less than 0.060-inch nominal-thickness steel sheet.
 - a. Height: 4 inches.
 2. Recess Trim: Fabricated from 0.048-inch nominal-thickness steel sheet.
 3. Filler Panels: Fabricated from manufacturer's standard thickness, but not less than 0.036-inch nominal-thickness steel sheet.
 4. Finished End Panels: Fabricated from 0.024-inch nominal-thickness steel sheet.
 - K. Finish: Baked enamel or powder coat.
 1. Color(s): As selected by Architect from manufacturer's full range.

2.03 LOCKER BENCHES

- A. Provide bench units with overall assembly height of 17-1/2 inches.
- B. Bench Tops: Manufacturer's standard one-piece units, with rounded corners and edges.
 1. Size: Minimum 9-1/2 inches wide by 1-1/4 inches thick except provide minimum 20-inch- wide tops where accessible benches are indicated.
 2. Laminated clear hardwood with one coat of clear sealer on all surfaces and one coat of clear lacquer on top and sides.
- C. Fixed Pedestals: Manufacturer's standard supports, with predrilled fastener holes for attaching bench top and anchoring to floor, complete with fasteners and anchors, and as follows:
 1. Tubular Steel: 1-1/2-inch- diameter steel tubing threaded on both ends, with standard pipe flange at top and bell-shaped cast-iron base; with baked-enamel or powder-coat finish; anchored with exposed fasteners.
 - a. Color: Match metal lockers.

2.04 FABRICATION

- A. Fabricate metal lockers square, rigid, and without warp and with metal faces flat and free of dents or distortion. Make exposed metal edges safe to touch and free of sharp edges and burrs.
 1. Form body panels, doors, shelves, and accessories from one-piece steel sheet unless otherwise indicated.
 2. Provide fasteners, filler plates, supports, clips, and closures as required for complete installation.

- B. Fabricate each metal locker with an individual door and frame; individual top, bottom, and back; and common intermediate uprights separating compartments. Factory weld frame members of each metal locker together to form a rigid, one-piece assembly.
- C. Knocked-Down Construction: Fabricate metal lockers using nuts, bolts, screws, or rivets for nominal assembly at Project site.
- D. Accessible Lockers: Fabricate as follows:
 - 1. Locate bottom shelf no lower than 15 inches above the floor.
 - 2. Where hooks, coat rods, or additional shelves are provided, locate no higher than 48 inches above the floor.
- E. Hooks: Manufacturer's standard ball-pointed type, aluminum or steel; zinc plated.
- F. Coat Rods: Fabricated from 1-inch diameter steel, chrome finished.
- G. Identification Plates: Manufacturer's standard, etched, embossed, or stamped aluminum plates, with numbers and letters at least 3/8 inch high.
- H. Continuous Base: Formed into channel or zee profile for stiffness, and fabricated in lengths as long as practical to enclose base and base ends of metal lockers; finished to match lockers.
- I. Recess Trim: Fabricated with minimum 2-1/2-inch face width and in lengths as long as practical; finished to match lockers.
- J. Filler Panels: Fabricated in an unequal leg angle shape; finished to match lockers. Provide slip-joint filler angle formed to receive filler panel.
- K. Finished End Panels: Designed for concealing unused penetrations and fasteners, except for perimeter fasteners, at exposed ends of nonrecessed metal lockers; finished to match lockers.
 - 1. Provide one-piece panels for double-row (back-to-back) locker ends.

2.05 STEEL SHEET FINISHES

- A. Factory finish steel surfaces and accessories except chrome-plated surfaces.
- B. Baked-Enamel Finish: Immediately after cleaning, pretreating, and phosphatizing, apply manufacturer's standard thermosetting baked-enamel finish. Comply with paint manufacturer's written instructions for application, baking, and minimum dry film thickness.
- C. Powder-Coat Finish: Immediately after cleaning and pretreating, electrostatically apply manufacturer's standard, baked-polymer, thermosetting powder finish. Comply with resin manufacturer's written instructions for application, baking, and minimum dry film thickness.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine walls, floors, and support bases, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. General: Install level, plumb, and true; shim as required, using concealed shims.
 - 1. Anchor locker runs at ends and at intervals recommended by manufacturer, but not more than 36 inches o.c. Using concealed fasteners, install anchors through backup reinforcing plates, channels, or blocking as required to prevent metal distortion.
 - 2. Anchor single rows of metal lockers to walls near top of lockers and to floor.
 - 3. Anchor back-to-back metal lockers to floor.
- B. Knocked-Down Metal Lockers: Assemble with standard fasteners, with no exposed fasteners on door faces or face frames.
- C. Equipment and Accessories: Fit exposed connections of trim, fillers, and closures accurately together to form tight, hairline joints, with concealed fasteners and splice plates.
 - 1. Attach hooks with at least two fasteners.
 - 2. Attach door locks on doors using security-type fasteners.
 - 3. Identification Plates: Identify metal lockers with identification indicated on Drawings.
 - a. Attach plates to each locker door, near top, centered, with at least two aluminum rivets.
 - 4. Attach recess trim to recessed metal lockers with concealed clips.
 - 5. Attach filler panels with concealed fasteners. Locate filler panels where indicated on Drawings.
 - 6. Attach finished end panels with fasteners only at perimeter to conceal exposed ends of nonrecessed metal lockers.
- D. Fixed Locker Benches: Provide no fewer than two pedestals for each bench, uniformly spaced not more than 72 inches apart. Securely fasten tops of pedestals to undersides of bench tops, and anchor bases to floor.

3.03 ADJUSTING, CLEANING, AND PROTECTION

- A. Clean, lubricate, and adjust hardware. Adjust doors and latches to operate easily without binding.
- B. Protect metal lockers from damage, abuse, dust, dirt, stain, or paint. Do not permit use during construction.
- C. Touch up marred finishes, or replace metal lockers that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by locker manufacturer.

END OF SECTION 10 51 13

SECTION 10 56 00**STORAGE EQUIPMENT****PART 1 - GENERAL**

The General Provisions of the Contract, including General and Special Conditions and the requirements of Division 1, apply to the Work in this Section.

1.01 WORK INCLUDED

- A. Equipment items as listed below by Equipment Identifier:
1. 1106 Cabinet, five drawer, 33 inches, underbench (Ref. Part 2.01)
 2. 1140 Cabinet, flammable materials, large (Ref. Part 2.02)
 3. 1185 Cabinet, storage, shop (Ref. Part 2.03)
 4. 1200 Cart, parts (Ref. Part 2.04)
 5. 1455 Rack, bulk storage (Ref. Part 2.05)
 6. 1545 Rack, pallet, high bay (Ref. Part 2.06)
 7. 1688 Shelving unit, 18 inches (Ref. Part 2.07)
 8. 1698 Shelving unit, 18 inches, with six drawers (Ref. Part 2.08)
- B. Installation of equipment with labor, services, and incidentals necessary for complete and operational equipment installation.
- C. Utilities to be roughed in at location recommended by manufacturer.

1.02 QUALITY ASSURANCE

- A. Equipment shall be produced by a manufacturer of established reputation with a minimum of five years experience supplying specified equipment.

1.03 SUBMITTALS

- A. Product Data:
1. Submit Product Data in accordance with Division 1 - General Requirements of these specifications.
 2. Restrict submitted material to pertinent data. For instance, do not include manufacturer's complete catalog when pertinent information is contained on a single page.
 3. Additional costs resulting from substitution of products other than those specified, including drawing changes and construction, will be at the expense of the contractor.
- B. Operations and Maintenance Manual:
1. Submit Operations and Maintenance Manuals in accordance with Division 1- General Requirements of these specifications.
 2. Provide complete parts, operating, and maintenance manual covering equipment at time of installation.

3. Description of system and components.
4. Schematic diagrams of electrical, plumbing, and compressed air system.
5. Manufacturer's printed operating instructions.
6. Printed listing of periodic preventive maintenance items and recommended frequency to validate warranties. Failure to provide maintenance information will indicate that preventive maintenance is not a condition for validation of warranties.

1.04 PRODUCT SUBSTITUTIONS

- A. Follow requirements specified in Division 1 - General Requirements.
- B. Additional costs resulting from substitution of products other than those specified, by model number, including drawing changes and construction, will be at the expense of the Contractor.
- C. Substitution Approval: Prior to delivery or installation, submittals for each equipment item by Equipment Identifier shall be provided in accordance with Division 1 - General Requirements. Acceptance will be based on the technical requirements herein as determined by Owner and Architect.

1.05 WARRANTY

- A. Warrant work specified herein for one year from substantial completion against defects in materials, functions, and workmanship.
- B. Warranty shall include materials and labor necessary to correct defects.
- C. Defects shall include, but not be limited to noisy, rough or substandard operation; loose, damaged, and missing parts; and abnormal deterioration of finish. Defects shall not include damage due to neglect, misuse, or situations resulting from non-performance of a manufacturer's recommended preventive maintenance schedule.
- D. Submit warranties in accordance with Division 1 - General Requirements of these specifications.
- E. All parts shall be readily available locally in the United States.

1.06 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver equipment in manufacturer's containers, appropriately packaged and/or crated for protection during domestic shipment and storage in humid and/or dusty conditions.
- B. Indelibly label all containers, including those contained in others, on outside with item description(s) per title and Equipment Identifier of this specification.
- C. Provide equipment and material specified complete in one shipment for each equipment item. Split or partial shipments are not permissible.

1.07 BUY AMERICA COMPLIANCE

- A. The Contractor shall comply with the applicable Buy America requirements set forth in 49 U.S.C. 5323(j) and the applicable regulations in 49 C.F.R. Part 661, as amended. If the Contractor procures any capital items with Federal funds, it is the Contractor's responsibility to obtain the Buy America certification required under such regulations.
- B. Reference Division 1 for Buy America provisions.

PART 2 - PRODUCTS**2.01 CABINET, FIVE DRAWER, 33 INCHES, UNDERBENCH**
Equipment Identifier: 1106

- A. Manufacturer's Reference:
 - 1. Prime manufacturer: Specifications are based on equipment identified herein by manufacturer's name and model to establish minimal acceptable standards of quality, features, performance, and construction.
 - a. Eupto, Tatamy, PA (610) 253-2775
 - b. Model: 4433 with accessories
 - 2. Alternate manufacturers: Contingent upon compliance with these specifications and documentation requirements set forth in SUBMITTALS, equipment produced by other manufacturers, including the following, may be considered as equal.
 - a. Lyon Metal Products, Inc., Aurora, IL (708) 892-8941
 - b. Stanley Storage Systems, Allentown, PA (610) 797-6600
- B. Capacities/Dimensions:
 - 1. Overall dimensions, nominal:
 - a. Width: 30 inches
 - b. Depth: 27-3/4 inches
 - c. Height: 33-1/2 inches
 - 2. Quantity of drawers: Six
 - 3. Drawer capacity: 400 pounds each (minimum)
 - 4. Drawer dimensions:
 - 5. Usable width: 25-1/8 inches
 - a. Usable depth: 25-1/8 inches
 - b. Drawer usable height (drawers numbered top to bottom):
 - 1) Drawers 1: 3 inches
 - 2) Drawer 2-4: 4-1/2 inches
 - 3) Drawer 5 and 6: 6 inches

4) Drawer 5: 7 inches

C. Features/Performance/Construction:

1. Cabinet shall be heavy gauge channel formed sheet steel with mountings permitting installation of various height drawers, front columns with drilled and tapped bolt holes.
2. Base design shall include front and rear forklift openings of ample strength to permit moving of fully loaded cabinet. Front base plate shall be provided. Base shall be drilled for bolting to the floor.
3. Drawer suspension shall be designed for total interchangeability for all drawer heights. Sealed steel roller bearing system shall permit full drawer extension at rated capacity without sagging.
4. Drawers and trays shall be fabricated of smooth sheet metal with partition and divider mounting hole grid punched on 3/4 inch centers. Drawer walls shall be slotted on 3/4 inch centers for mounting dividers and partitions.
5. Drawer pulls shall be nominal 3/4 drawer width with 1 inch high label holder provided with paper labels and protective vinyl shields and end caps.
6. Drawer dividers shall have a minimum of 12 divided sections.
7. Drawer heights shall be available in front heights of 3 to 12 inches in not over 1-1/2 inch increments.
8. Provide seismic bracing and anchorage to meet any local, state, and national codes and provisions.

D. Accessories: Drawer divider sets

1. Equipto No. 4133F10, one each
2. Equipto No. 4135F20, two each
3. Equipto No. 4134F15, three each

E. Finish: Phosphate primer covered by durable enamel in Owner's choice of manufacturer's standard colors

2.02 CABINET, FLAMMABLE MATERIALS, LARGE
Equipment Identifier: 1140

A. Manufacturer's Reference:

1. Prime manufacturer: Specifications are based on equipment identified herein by manufacturer's name and model to establish acceptable standards of quality, performance, features, and construction.
 - a. Equipto, Tatamy, PA (610) 253-2775
 - b. Model: FSC 45S
2. Alternate manufacturers: *Contingent upon compliance with these specifications* and documentation requirements set forth in SUBMITTALS, equipment produced by other manufacturers, including the following, *may* be considered as equal.

- a. Lyon Metal Products, Inc., Aurora, IL (630) 892-8941
- b. Justrite Manufacturing Co., Des Plaines, IL (847) 298-9250

B. Capacities/Dimensions:

1. Storage capacity: Up to nine each, 5 gallon containers
2. Overall dimensions, nominal:
 - a. Width: 43 inches
 - b. Depth: 18 inches
 - c. Height: 65 inches
3. Shipping weight, nominal: 353 pounds

C. Features/Performance/Construction:

1. Cabinet shall comply with NFPA combustible liquids Code No. 30 and OSHA safety requirements.
2. Construction shall consist of double wall 18 gauge sheet steel with 2 inch air space between inner and outer walls.
3. Cabinet shall have a 2 inch pan-type bottom.
4. Two screened flame arrester vents per cabinet, one each at left side bottom and right side top, shall be threaded for and provided with 2 inch NPT steel plugs.
5. Leveling feet shall be provided at all four corners.
6. Electrical grounding attachments shall be provided on each side.
7. A spring-loaded fusible link with 160 degree F melting point shall actuate self closing double swinging doors mounted with full-length piano hinges. Doors shall be provided with three-point latch mechanism and key lock.
8. Two each adjustable shelves shall be provided between 5-3/8 inches from top and 7-5/16 inches from bottom on 1-5/8 inch centers.
9. Provide seismic bracing and anchorage to meet any local, state, and national codes and provisions.

D. Finish: Durable enamel in safety sun yellow with "FLAMMABLE - KEEP FIRE AWAY" in minimum 4 inch bright red letters across doors

2.03 CABINET, STORAGE, SHOP

Equipment Identifier: 1185

A. Manufacturer's Reference:

1. Prime manufacturer: Specifications are based on equipment identified herein by manufacturer's name and model to establish minimal acceptable standards of quality, features, performance, and construction.
 - a. Equipto, Tatamy, PA (610) 253-2775
 - b. Model: 1710
2. Alternate manufacturers: *Contingent upon compliance with these specifications* and documentation requirements set forth in SUBMITTALS,

equipment produced by other manufacturers, including the following, *may* be considered as equal.

- a. Lyon Metal Products, Inc., Aurora, IL (630) 892-8941
- b. Republic Storage Systems, Canton, OH (216) 438-5800

B. Capacities/Dimensions:

1. Shelf capacity: 200 pounds per shelf (minimum)
2. Overall dimensions:
 - a. Width: 36 inches
 - b. Depth: 18 inches
 - c. Height: 78 inches
 - d. Space remaining 4 shelves evenly, approximately 15 inches center to center

C. Features/Performance/Construction:

1. Four shelves, flanged, constructed of 18 gauge steel. Shelf adjustments on maximum 2 inch centers without removing fasteners.
2. Doors shall have a three-point locking system with factory key-lockable handle. Doors shall open a full 180 degrees and be flush mounted when closed with latching actuated cast steel handle.
3. Each door shall be hinged on three welded heavy-duty steel pin hinges.
4. Back, front, and sides shall be flush with no bolt heads on front or sides.
5. Provide seismic bracing and anchorage to meet any local, state, and national codes and provisions.

D. Finish: Durable enamel in Owner's choice of manufacturer's standard colors

2.04 CART, PARTS

Equipment Identifier: 1200

A. Manufacturer's Reference:

1. Prime manufacturer: Specifications are based on equipment identified herein by manufacturer's name and model to establish minimal acceptable standards of quality, features, performance, and construction.
 - a. Pucel Enterprises, Inc., Cleveland, OH (216) 881-4604
 - b. Model: 2448-DT-3-P
2. Alternate manufacturers: *Contingent upon compliance with these specifications* and documentation requirements set forth in SUBMITTALS, equipment produced by other manufacturers, including the following, *may* be considered as equal.
 - a. Hodge Manufacturing Co., Springfield, MA (413) 781-6800
 - b. Equipto, Tatamy, PA (610) 253-2775

B. Capacities/Dimensions:

1. Cart capacity: 1,000 pounds (minimum)
2. Overall dimensions:
 - a. Width: 24 inches
 - b. Length: 48 inches
 - c. Height: 32-1/2 inches

C. Features/Performance/Construction:

1. Cart and shelves shall be constructed of 12 gauge steel.
2. Shelves shall be tray style with a clearance between shelves of 10 inches.
3. Casters shall be phenolic with two casters rigid and two casters swivel. Casters shall be able to accommodate 1,000 pounds.

D. Finish: Durable enamel in Owner's choice of manufacturer's standard colors

2.05 RACK, BULK STORAGE
Equipment Identifier: 1455

A. Manufacturer's Reference:

1. Prime manufacturer: Specifications are based on equipment identified herein by manufacturer's name and model to establish acceptable standards of quality, performance, features, and construction.
 - a. Equipto, Tatamy, PA (610) 253-2775
 - b. Model: 1028D62S (starter unit) and/or 1028D62A (add-on unit) and Accessories
2. Alternate manufacturers: *Contingent upon compliance with these specifications* and documentation requirements set forth in SUBMITTALS, equipment produced by other manufacturers, including the following, *may* be considered as equal.
 - a. Lyon Metal Products Inc., Aurora, IL (630) 892-8941
 - b. Republic Storage Systems, Canton, OH (216) 438-5800

B. Capacities/Dimensions:

1. Beams:
 - a. Capacity: 2,630 pounds per pair of beams
 - b. Dimensions:
 - 1) Length: 72 inches
 - 2) Width: 3-1/2 inches
 - 3) Depth: 2 inches overall front to back
 - c. Number of beams per rack section: Eight total (four pairs)

2. Uprights:
 - a. Capacity: 8,900 pounds per upright
 - b. Dimensions:
 - 1) Width: 1-5/8 inches
 - 2) Depth, nominal: 24 inches
 - 3) Height: 96 inches
 - c. Number of uprights per rack section: Two minimum
 3. Overall dimensions, nominal:
 - a. Length: 72 inches
 - b. Width: 24 inches
 - c. Height: 96 inches
 4. Weight: 220 pounds
- C. Features/Performance/Construction:
1. Beams:
 - a. Construction: Beams shall be solid shaped welded heavy gauge steel with heavy beam clips MIG-welded to beam ends.
 - b. Attachment: Beam clips shall have three beam hooks each for insertion into upright slots.
 2. Supports: Tie bars for each pair of beams shall fit into slots in beams. There shall be a minimum of two supports provided for each pair of beams.
 3. Uprights:
 - a. Construction: Upright posts shall be heavy duty 1-5/8 by 1-13/16 inch welded 16 gauge steel with tubular steel cross and diagonal members.
 - b. Adjustment: Upright posts shall have tapered slots on 1-1/2 inch centers for vertical beam adjustment
 4. Decking:
 - a. Construction: Decking shall be 18 gauge corrugated shaped steel.
 - b. Capacity: Decking shall have a capacity of 2,778 pounds but load is limited to support capacity of beams and uprights.
 5. Provide seismic bracing and anchorage to meet any local, state, and national codes and provisions.

- D. Accessories:
1. Anchors: Floor, for seismic bracing, Equipto No. 190317A, four per starter unit, two per add on unit
- E. Finish: Durable enamel in Owner's choice of manufacturer's standard colors
- 2.06 RACK, PALLET, HIGH BAY
Equipment Identifier: 1545
- A. Manufacturer's Reference:
1. Prime manufacturer: Specifications are based on equipment identified herein by manufacturer's name and model to establish acceptable standards of quality, performance, features, and construction.
 - a. Lyon Metal Products, Inc., Aurora, IL (630) 892-8941
 - b. Model: Uprights U0619242, Beams B6500108, and Decking WD5242L
 2. Alternate manufacturers: *Contingent upon compliance with these specifications* and documentation requirements set forth in SUBMITTALS, equipment produced by other manufacturers, including the following, *may* be considered as equal.
 - a. Unarco Materials Handling, Springfield, TN (800) 862-7271
 - b. Lista, Holliston, MA (508) 429-1350
- B. Capacities/Dimensions:
1. Beams:
 - a. Minimum capacity: 4,900 pounds per pair of beams
 - b. Dimensions:
 - 1) Length: 108 inches
 - 2) Thickness: 4-3/10 inches
 - c. Installed beam height from finished floor:
 - 1) Top beams: 192 inches
 - 2) Remaining four beam levels: 36 inch spacing
 - 3) Verify beam heights with Owner prior to installation
 2. Uprights:
 - a. Capacity: 29,055 pounds per pair of uprights
 - b. Dimensions:
 - 1) Thickness: 3 inches wide by 3 inches deep
 - 2) Depth: 42 inches
 - 3) Height: 192 inches

3. Decking:
 - a. Width: 52 inches
 - b. Depth: 42 inches
 - c. Number of channels: Three
 - d. Capacity: 2,500 pounds
 - e. Panels per shelf: Two
 4. Overall dimensions, nominal:
 - a. Width: 108 inches
 - b. Depth: 42 inches
 - c. Height: 192 inches
- C. Features/Performance/Construction:
1. Beams:
 - a. Construction: Beams shall be welded, step-type, heavy gauge steel box channel.
 - b. Attachment: High tensile studs, four each on each end shall engage tapered keyhole slots in uprights. Integral safety catch automatically snaps and locks into place when beam is properly seated.
 2. Uprights:
 - a. Construction: Continuously MIG welded, heavy gauge steel box section uprights shall have deep channel cross and diagonal K-brace members.
 - b. Adjustment: Tapered keyhole slots on 2 inch centers shall be provided for vertical beam adjustments.
 - c. Base plate: Heavy gauge steel shall be LAP welded to upright with holes for anchoring to floor.
 - d. Row ends: An extra upright frame shall be provided to finish each row as indicated on equipment drawings.
 3. Decking:
 - a. Wire mesh: Continuously MIG welded, 2-1/2 by 4 inches by 6 gauge
 - b. Support channels: 13 gauge steel
 4. Provide seismic bracing and anchorage to meet any local, state, and national codes and provisions.
- D. Finish: Durable enamel in Owner's choice of manufacturer's standard colors

2.07 SHELVING UNIT, 18 INCHES

Equipment Identifier: 1688

A. Manufacturer's Reference:

1. Prime manufacturer: Specifications are based on equipment identified herein by manufacturer's name and model to establish minimal acceptable standards of quality, features, performance, and construction.
 - a. Equipto, Tatamy, PA (610) 253-2775
 - b. Model: 773-8S shelving unit (with 773-8A add on and accessories)
2. Alternate manufacturers: *Contingent upon compliance with these specifications* and documentation requirements set forth in SUBMITTALS, equipment produced by other manufacturers, including the following, *may* be considered as equal.
 - a. Lyon Metal Products, Inc., Aurora, IL (630) 892-8941
 - b. Stanley Vidmar, Allentown, PA (610) 797-6600

B. Capacities/Dimensions:

1. Number of shelves: Eight
2. Shelf capacity: 1,000 pounds per shelf
3. Overall dimensions, nominal:
 - a. Width: 36 inches (72 inches with add on)
 - b. Depth: 18 inches
 - c. Height: 84 inches
4. Installed height from finished floor, nominal:
 - a. Bottom shelf: 4-1/2 inches
 - b. Top shelf: 84 inches
 - c. Space remaining bottom six shelves evenly, approximately 12 inches center to center, and the top two shelves 10-1/2 inches center to center
5. Weight: 170 pounds

C. Features/Performance/Construction:

1. Shelf construction shall be double flange 18 gauge steel and double flanged box-formed edges on all four sides.
2. Uprights shall be double flanged uprights with tapered bracket slots punched on 1-1/2 inch centers for vertical shelf adjustment.
3. Shelf fastening shall consist of slip-in shelf brackets which reinforce and securely lock shelf into place in all four corners.
4. Units shall share common end panels with adjoining units. Back-to-back units shall be joined with common upright joints.

-
5. Provide seismic bracing and anchoring to meet any local, state, and national codes and provisions.
- D. Accessories:
1. Anchors: Floor, for seismic bracing, Equipto No. 190317A, four per starter unit, two per add-on unit
- E. Finish: Durable enamel in owner's choice of manufacturer's standard colors
- 2.08 SHELIVING UNIT, 18 INCHES, WITH SIX DRAWERS
Equipment Identifier: 1698
- A. Manufacturer's Reference:
1. Prime manufacturer: Specifications are based on equipment identified herein by manufacturer's name and model to establish minimal acceptable standards of quality, features, performance, and construction.
 - a. Equipto, Tatamy, PA (610) 253-2775
 - b. Model: 4205DN
 2. Alternate manufacturers: *Contingent upon compliance with these specifications* and documentation requirements set forth in SUBMITTALS, equipment produced by other manufacturers, including the following, *may* be considered as equal.
 - a. Lyon Metal Products, Inc., Aurora, IL (630) 892-8941
 - b. Lista International Corp., Holliston, MA (508) 429-1350
- B. Capacities/Dimensions:
1. Number of shelves: Four total
 2. Number of drawers: Six total
 3. Shelf capacity: 1,000 pounds per shelf
 4. Drawer capacity: 200 pounds per drawer (minimum)
 5. Overall dimensions, nominal:
 - a. Width: 36 inches
 - b. Depth: 18 inches
 - c. Height: 84 inches
 6. Drawer dimensions, nominal:
 - a. Width: 36 inches
 - b. Depth: 18 inches
 - c. Height: 6 inches
 7. Installed shelf height from finished floor, nominal (shelves numbered one through four, top to bottom):
 - a. Shelf one: 74 inches

- b. Shelf two: 62 inches
 - c. Shelf three: 50 inches
 - d. Shelf four: 4-1/2 inches
 - e. Shelf height: 12 inches
- C. Features/Performance/Construction:
- 1. Shelf construction shall be double flange 18 gauge steel with box-formed edges on all four sides with front and rear shelf edge reinforced channels.
 - 2. Uprights shall be double flanged uprights with tapered bracket slots punched on 1-1/2 inch centers for vertical shelf adjustment.
 - 3. Shelf fastening shall consist of slip-in shelf brackets which reinforce and securely lock shelf into place in all four corners.
 - 4. Units shall share common end panels with adjoining units or common back panels when installed back-to-back. Back-to-back units shall be joined with common upright joints.
 - 5. Rolling drawers shall be 22 gauge steel with side and back of drawer to be punched with slots to accommodate vertical partitions and dividers. Drawer roller guides to be bolted front to back at uprights.
 - 6. Shelves to be installed above and below banks of drawers.
 - 7. Provide seismic bracing and anchorage to meet any local, state, and national codes and provisions.
- D. Accessories: Drawer, 36 inches wide, six per unit, with dividers
- E. Finish: Durable enamel in owner's choice of manufacturer's standard colors

PART 3 - EXECUTION

3.01 INSPECTION

- A. Coordinate location of rough-in work and utility stub-outs to assure match with equipment to be installed.
- B. Inspect delivered equipment for damage from shipping and exposure to weather. Compare delivered equipment with packing lists and specifications to assure receipt of all equipment items and specified accessories.

3.02 INSTALLATION

- A. Perform work under direct supervision of Foreman of Construction Superintendent with authority to coordinate installation of scheduled equipment with Architect or designated representative.
- B. Install equipment in accordance with plans, shop drawings, and manufacturer's instructions:
 - 1. Positioning: Place equipment in accordance with any noted special positioning requirements generally level (or slight slope as required by instructions), plumb, and at right angles to adjacent work.

2. Fitting: Where field cutting or trimming is necessary, perform in a neat, accurate, professional manner without damaging equipment or adjacent work.
 3. Anchorage: Attach equipment as directed by Architect or designated representative. Installation fasteners shall be installed to avoid scratching or damaging adjacent surfaces.
- C. Upon completion of work, finish surfaces shall be free of tool marks, scratches, blemishes, and stains.

3.03 TESTING

- A. After final installation is complete and prior to authorizing payment, specified equipment shall be checked with specifications in the presence of the Architect or designated representative using acceptance procedures provided by the manufacturer.

3.04 CLEANUP

- A. Touch-up damage to painted finishes.
- B. Wipe and clean equipment of any oil, grease, and solvents, and make ready for use.
- C. Clean area around equipment installation and remove packing and installation debris from job site.
- D. Notify Architect or designated representative for acceptance inspection.

END OF SECTION

SECTION 11 11 00**VEHICLE SERVICE EQUIPMENT****PART 1 - GENERAL**

The General Provisions of the Contract, including General and Special Conditions and the requirements of Division 1, apply to the Work in this Section.

1.01 WORK INCLUDED

- A. Equipment items as listed below by Equipment Identifier:
1. 2161 Compressor, air, receiver mounted, 10 HP duplex (Ref. Part 2.1)
 2. 2228 Dryer, air, refrigerated, 100 CFM (Ref. Part 2.2)
 3. 7520 Pump, air piston, 10:1 ratio (GO) (Ref. Part 2.3)
 4. 7540 Pump, diaphragm, used fluid evacuation (UGO) (Ref. Part 2.4)
 5. 7700 Reel banks, general (Ref. Part 2.5)
 6. 7720 Reel bank (CA, GO) (Ref. Part 2.6)
 7. 7960 Tank, double wall, cube, 280 gallon (GO, UGO) (Ref. Part 2.7)
 8. 7999 Receiver, used oil, 25 gallon (Ref. Part 2.8)
- B. Roughing-in installation of equipment, and final connection of utilities, with labor, services, and incidentals necessary for complete and operational equipment installation.

1.02 REFERENCES

- A. ASME Code for Unfired Pressure Vessels

1.03 QUALITY ASSURANCE

- A. Manufacturer's Representative:
1. Installation: Provide a qualified manufacturer's representative at site to supervise work related to equipment installation, check out, and start up.
 2. Training: Provide a qualified manufacturer's representative to provide training to Owner's maintenance personnel in operation and maintenance of specified equipment.

1.04 SUBMITTALS

- A. Product Data:
1. Submit Product Data in accordance with Division 1 - General Requirements of these specifications.
 2. Restrict submitted material to pertinent data. For instance, do not include manufacturer's complete catalog when pertinent information is contained on a single page.
- B. Operations and Maintenance Manual:

1. Submit Operations and Maintenance Manuals in accordance with Division 1- General Requirements of these specifications.
 2. Provide complete parts, operating, and maintenance manual covering equipment at time of installation.
 3. Description of system and components.
 4. Schematic diagrams of electrical, plumbing, and compressed air system.
 5. Manufacturer's printed operating instructions.
 6. Printed listing of periodic preventive maintenance items and recommended frequency to validate warranties. Failure to provide maintenance information will indicate that preventive maintenance is not a condition for validation of warranties.
- C. Shop Drawings: Submit Shop Drawings in accordance with of Division 1 - General Requirements of these specifications.
- D. Include certified data for each unit and accessory system indicating the following:
1. Air compressor performance curves at summer design condition
 2. Intercooler performance at summer design condition
 3. Air dryer performance at 38 degrees F, dew point at 175 PSIG
 4. Indicate components, assembly, dimensions, weights and loadings, required clearances, location and size of field connections, intake air filter outline, blow-off silencer outline, main motor drive data, aftercoolers, control panel, and electrical pneumatic schematics.

1.05 PRODUCT SUBSTITUTIONS

- A. Follow requirements specified in Division 1 - General Requirements.
- B. Additional costs resulting from substitution of products other than those specified, by model number, including drawing changes and construction, will be at the expense of the Contractor.
- C. Substitution Approval: Prior to delivery or installation, submittals for each equipment item by Equipment Identifier shall be provided in accordance with Division 1 - General Requirements. Acceptance will be based on the technical requirements herein as determined by Owner and Architect.

1.06 WARRANTY

- A. Warrant work specified herein for one year from substantial completion against defects in materials, functions, and workmanship.
- B. Warranty shall include materials and labor necessary to correct defects.
- C. Defects shall include, but not be limited to noisy, rough or substandard operation; loose, damaged, and missing parts; and abnormal deterioration of finish. Defects shall not include damage due to neglect, misuse, or situations resulting from non-performance of a manufacturer's recommended preventive maintenance schedule.

1.07 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver equipment in manufacturer's containers, appropriately packaged and/or crated for protection during domestic shipment and storage in humid and/or dusty conditions.
- B. Indelibly label all containers, including those contained in others, on outside with item description(s) per title and Equipment Identifier of this specification.
- C. Provide equipment and material specified complete in one shipment for each equipment item. Split or partial shipments are not permissible.

1.08 LABELING

- A. Manufacturer shall securely attach in a prominent location, on each major item of equipment, a non-corrosive nameplate showing manufacturer's name, address, model number, serial number, and pertinent utility or operating data.
- B. All electrical equipment and materials shall be new and shall be listed by Underwriter's Laboratories, Inc. (UL) in categories for which standards have been set by that agency and labeled as such in the manufacturer's plant.
- C. Provide air receivers meeting requirements of ASME Code for Unfired Pressure Vessels and carry ASME approval stamp.

1.09 BUY AMERICA COMPLIANCE

- A. The Contractor shall comply with the applicable Buy America requirements set forth in 49 U.S.C. 5323(j) and the applicable regulations in 49 C.F.R. Part 661, as amended. If the Contractor procures any capital items with Federal funds, it is the Contractor's responsibility to obtain the Buy America certification required under such regulations.
- B. Reference Division 1 for Buy America compliance.

PART 2 - PRODUCTS**2.01 COMPRESSOR, AIR, RECEIVER MOUNTED, 10 HP DUPLEX**
Equipment Identifier: 2161

- A. Manufacturer's Reference:
 - 1. Prime manufacturer: Specifications are based on equipment identified herein by manufacturer's name and model to establish acceptable standards of quality, performance, features, and construction.
 - a. Champion, Princeton, IL (815) 875-3321
 - b. Model: HR10D-25 with accessories (Reference Sheet Q750 Air Compressor Detail)
 - 2. Alternate manufacturers: *Contingent upon compliance with these specifications* and documentation requirements set forth in SUBMITTALS,

equipment produced by other manufacturers, including the following, *may* be considered as equal.

- a. Ingersoll Rand, Davidson, NC (704) 896-4000
 - b. Quincy Compressor, Quincy, IL (217) 222-7700
- B. General Description: Provide duplex compressor unit consisting of air-cooled motor compressors (10 HP), air receiver, after cooler, pressure reducing station, spring isolators and operating controls.
- C. Capacities/Dimensions:
1. Motors: 10 HP, two each
 2. Receiver: 200 to 250 gallons
 3. Rating: 175 PSIG
 4. Speed: 740 RPM
 5. Displacement: 86.2 CFM each
 6. Delivery: 69.6 CFM each
 7. Bore diameters: 4-5/8 and 2-1/2 inches
 8. Stroke: 3 inches
 9. Number of cylinders: Four
 10. Output valve: 3/4 inch NPT(F)
 11. Overall dimensions:
 - a. Width: 88 inches
 - b. Depth: 29 inches
 - c. Height: 62 inches
 12. Boltdown dimensions:
 - a. Length: 55 inches
 - b. Width: 27 inches
 13. Weight (approximate): 1,730 pounds
- D. Features/Performance/Construction:
1. Compressor construction:
 - a. Construct compressor unit with cast iron housing and head, heat treated forged steel or ductile iron shaft, aluminum alloy connection rods, aluminum pistons with lubricated carbon steel rings, high-strength alloy suction and discharge valves. Statically and dynamically balance rotating parts.
 - b. Mount motor and compressor on one-piece ribbed cast iron or welded steel base with provision for V-belt adjustment.
 2. After cooler:
 - a. Provide air compressor with air after cooler suitable for operation under 135 PSIG working pressure.

- b. Provide a belt guard style after cooler mounted on the compressor belt guard, with automatic condensate trap and automatic float drain.
 - c. After cooler capacity to cool discharge air to within 25 degrees F of ambient air temperature with compressors operating at specified capacity.
 3. Air receiver:
 - a. Provide vertical or horizontal receiver stamped ASME rated for working pressure of 200 PSIG. Flange or screw inlet and outlet connections, welded steel construction.
 - b. Fittings to include adjustable pressure regulator, safety valve, pressure gauge, drain cock, and automatic pneumatic tank drain.
 4. Pressure reducing valve:
 - a. Provide pressure reducing stations complete with automatic reducing valve and bypass, and low pressure side relief valve and gauge.
 - b. Compressor shall be provided with automatic start/stop capacity controls. In addition, provide centrifugal unloading to ensure for an unloaded compressor at start-up.
 - c. Valve capacity suitable to compressor reduce pressure from 50 PSI to 180 PSI. Pressure reducing valve to be adjustable upward from reduced pressure.
 - d. Provide valves with bronze or semi-steel bodies with stainless steel springs, stems, and seats.
- E. Controls:
 1. Pressure switch to cutout at 100 PSI with minimum differential of 20 PSI.
 2. Compressor regulation through a lead-lag switch.
 3. Provide electrical automatic alternation. In the event one compressor fails, another compressor automatically maintains air pressure.
- F. Accessories:
 1. Magnetic Starter
 2. Vibration isolators, Model No. VI
 3. Automatic pneumatic tank drain, Model No. ATDP
 4. Oil monitor, Model No. LOLM
 5. Air-cooled aftercooler, Model No. ACAC (x2)
 6. Condensation Filter, Model No. CFF170A
- A. Utility Requirements:
 1. Electrical: 460 VAC, 3 phase, 10 HP per motor (20 HP total)
- B. Finish: Durable enamel in manufacturer's standard color

2.02 DRYER, AIR, REFRIGERATED, 100 CFM
Equipment Identifier: 2228

A. Manufacturer's Reference:

1. Prime manufacturer: Specifications are based on equipment identified herein by manufacturer's name and model to establish minimal acceptable standards of quality, features, performance, and construction.
 - a. Champion, Princeton, IL (815) 875-3321
 - b. Model: CRN100 (Reference Sheet Q750 Air Dryer Detail)
2. Alternate manufacturers: *Contingent upon compliance with these specifications* and documentation requirements set forth in SUBMITTALS, equipment produced by other manufacturers, including the following, *may* be considered as equal.
 - a. Ingersoll Rand, Davidson, NC (704) 896-4000
 - b. Quincy Compressors, Quincy, IL (217) 222-7000

B. Capacities/Dimensions:

1. Capacity:
 - a. 38 degrees F: 100 CFM
 - b. 50 degrees F: 130 CFM
2. Overall dimensions:
 - a. Width: 29 inches
 - b. Depth: 20 inches
 - c. Height: 38 inches
3. Drain connection: 1 inch NPT(F)
4. Air connection: 1 inch NPT(M)
5. Maximum working pressure: 232 PSIG (Level 1 controller standard)
6. Weight: 251 pounds

C. Features/Performance/Construction:

1. Provide refrigerated air dryer of self-contained mechanical refrigeration type complete with heat exchanger, refrigeration compressor, moisture removal trap, internal wiring and piping, and full refrigerant charge.
2. Provide air inlet and outlet connections at same level and factory insulated.
3. Heat exchangers to consist of air-to-air and refrigerant-to-air coils. Provide centrifugal type moisture separator located at discharge of heat exchanger. Provide heat exchangers with automatic control system to bypass refrigeration system on low or no load condition.

4. Refrigeration unit of hermetically sealed type to operate continuously to maintain specified 35 degree F dew point. House unit in steel cabinet provided with access door and panel for maintenance and inspection.
 5. Provide dryer with air inlet temperature gauge, air inlet pressure gauge, ON/OFF switch, high temperature LED, status indicators, refrigerant gauge, and Level 1 controller.
 6. Provide seismic bracing and anchorage to meet any local, state, and national codes and provisions.
- D. Utility Requirements:
1. 120 VAC, 1 phase, 1/2 HP
- E. Finish: Durable enamel in manufacturer's standard color
- 2.03 PUMP, AIR PISTON 10:1 RATIO (GO)
Equipment Identifier: 7520
- A. Manufacturer's Reference:
1. Prime manufacturer: Specifications are based on equipment identified by manufacturer's name and model to establish acceptable standard of quality, performance, features and construction.
 - a. Graco, Inc., Minneapolis, MN (612) 623-6000
 - b. Model: Fire-Ball 225853 (Reference Sheet Q750 Tank Mounted Piston Pump Detail)
 2. Alternate manufacturers: *Contingent upon compliance with these specifications* and documentation requirements set forth in SUBMITTALS, equipment produced by other manufacturers, including the following, *may* be considered as equal.
 - a. Balcrank Corporation, Weaverville, NC (828) 645-4261
 - b. Lincoln Industrial Corporation, St. Louis, MO (314) 679-4200
- B. Capacities/Dimensions:
1. Maximum fluid pressure: 1,800 PSI
 2. Air motor diameter: 4-1/4 inches
 3. Operating range: 40 to 180 PSI
 4. Continuous duty flow rate: 3 to 4 GPM
 5. Air consumption (approximate) at 100 PSI: 32 CFM
 6. Air inlet: 1/2 inch NPT (F)
 7. Material outlet: 3/4 inch NPT(F)
 8. Material inlet: 1-1/2 inch NPT(F)
- C. Features/Performance/Construction:
1. Provide pneumatic operated piston pump operable with maximum air pressure of 180 PSI.

2. Provide with complete assembly, including adapters for mounting on storage tanks, combination air filter, regulator, pressure gauge, lubricator, air and product valves, and hose and fitting kit suitable for product.
3. Air motor shall be a non-corrosive design with no metal-to-metal contact compatible with product being delivered.
4. Provide thermal relief valves for the pumping system.
5. Provide connection from pump back to product tank for proper drain back of fluid in piping riser line and pump.
6. Provide compressed air runaway valve before product fluid pump to eliminate unregulated fluid flow in the event of a product pipe break.

D. Accessories:

1. Air regulator, 1/2 inch: Graco No. 104266
2. Pressure gauge: Graco No. 100906
3. Low level cut off: Graco No. 203688

E. Utility Requirements:

1. Compressed air: 100 PSI, 32 CFM, provide filter, regulator, and valves

2.04 PUMP, DIAPHRAGM, USED FLUID EVACUATION (UGO)
Equipment Identifier: 7540

A. Manufacturer's Reference:

1. Prime manufacturer: Specifications are based on equipment identified by manufacturer's name and model to establish acceptable standards of quality, performance, features and construction.
 - a. Graco, Inc., Minneapolis, MN (612) 623-6000
 - b. Model: 647016 with accessories (Reference Sheet Q750 Pump for Used Oil Detail)
2. Alternate manufacturers: *Contingent upon compliance with these specification* and documentation requirements set forth in SUBMITTALS, equipment produced by other manufacturers, including the following, *may* be considered as equal.
 - a. Balcrank Corporation, Weaverville, NC (828) 645-4261
 - b. Lincoln Industrial Corporation, St. Louis, MO (314) 679-4300

B. Capacities/Dimensions:

1. Products: Used gear oil
2. Pump ratio: 1:1
3. Maximum air pressure: 125 PSI
4. Maximum fluid outlet pressure: 100 PSI
5. Free flow rate: 50 GPM
6. Continuous duty delivery: 2.4 GPM
7. Air consumption (approximate): 67 CFM

8. Air inlet: 1/2 inch NPT(F)
9. Fluid outlet: 1 inch NPT(M)
10. Fluid inlet: 1 inch NPT(M)
11. Regulator: 1/2 inch NPT(F)
12. Filter: 1/2 inch NPT(F)

C. Features/Performance/Construction:

1. Diaphragm pump shall provide 125 PSI air pressure for pump size and capacity as scheduled.
2. Pump shall be provided in complete assembly, including accessories for mounting on walls or adjacent to storage tanks as scheduled, combination air filter, regulator, coupler, nipple, air valve, wall bracket, relief kit, relief valves, wire and clamp, hose kit, adapter kit, and dual inlet manifold suitable for this product.
3. Materials: Compatible with product being shelved.
4. Pump shall handle oil, hydraulic oil, automatic transmission fluid, anti-freeze, windshield washer fluid, water, or fuel.
5. Pump shall have a tank monitoring system that shuts off the pump via solenoid valve when the used fluid tank is full.
6. Monitoring system shall notify users with a strobe light and an audible alarm system.
7. Audible alarm shall be a minimum of 250 milliamps.

D. Accessories:

1. Wall bracket accessory kit, Graco Model No. 24C637
2. Regulator/filter assembly: 1/2 inch NPT(f), Graco Model No. 246947 and appropriate fittings and hoses for a complete and operable installation
3. Fluid installation kit, Graco Model No. 240685, includes swivel union, 4 foot coupled fluid hose, short nipple, y-strainer, 10 foot coupled fluid hose, ball valve, elbow, and nipple
4. Drum adapter kit, Graco Model No. 240832, includes elbow, nipple, valve, male and female camlock couplers
5. Grounding wire and clamp, Graco Model No. 238909
6. Quick connect air coupler, 1/2 inch NPT, Graco Model No. 110199
7. Quick connect air nipple, 1/2 inch NPT, Graco Model No. 110196
8. Air muffler, Graco Model No. 112182
9. Tank monitoring system:
 - a. Manufacturer: BJ Enterprises, (800) 457-0749
 - b. Tank monitoring system power supply: BJE Model No. 007-7575, with strobe light, one each
 - c. Preferred option: Solenoid valve should be located on the main level. Run separate compressed air piping to the pump.
 - d. Solenoid valve: BJE Model No. 007SV-7580, one each
10. Provide label "USED GEAR OIL" on pump to identify product (minimum 1 inch lettering)

E. Utility Requirements:

1. Electrical: 120 VAC, 2 A, standard grounded receptacle
2. Compressed air: 125 PSI, 67 CFM, 1/2 inch NPT(F), provide filter, regulator, and valves

2.05 REEL BANKS, GENERAL
Equipment Identifier: 7700

A. Manufacturer's Reference:

1. Prime manufacturer: Specifications are based on equipment identified by manufacturer's name and model to establish acceptable standards of quality, performance, features and construction.
 - a. Graco, Inc., Minneapolis, MN (612) 623-6000
 - b. Model: HSL56B (CA), HSM65B (GO)
2. Alternate manufacturers: *Contingent upon compliance with these specification* and documentation requirements set forth in SUBMITALS equipment produced by other manufacturers, including the following, *may be considered as equal*.
 - a. Lincoln, A Pentair Company, St. Louis, MO (314) 679-4200
 - b. Balcrank Corporation, Weaverville, NC (828) 645-4261

B. Capacities/Dimensions:

1. Overall reel dimensions, nominal:
 - a. Reels (CA, GO):
 - 1) Width: 8-1/2 inches
 - 2) Height: 25-3/4 inches
 - 3) Reel diameter: 20 inches
2. Reel fluid inlet:
 - a. Air: 1/2 inch NPT(M)
 - b. Chassis grease: 3/8 inch NPT(M)
 - c. Other commodities: 1/2 inch NPT(M)
3. Hose:
 - a. Compressed Air:
 - 1) Length: 65 feet
 - 2) Inside diameter: 3/8 inch
 - 3) Working pressure: 180 PSI
 - b. Gear oil:
 - 1) Length: 50 feet
 - 2) Inside diameter: 1/2 inch

- 3) Working pressure: 1,500 PSI
 - c. Other commodities:
 - 1) Length: 50 feet
 - 2) Inside diameter: 1/2 inch
 - 3) Working pressure: 1,000 PSI
- C. Features/Construction:
1. Construction: Frames, discs, and drum shall be fabricated of heavy gauge steel.
 2. Double pedestal arm: Reel frame shall have double pedestal arms that are welded and gusseted.
 3. Hose guide arm: Reel hose guide arm shall be adjustable with nylon rollers on all four sides of roller assembly at hose opening.
 4. Ball stop: Adjustment of hose extension length shall be permitted by ball stop.
 5. Rewind mechanism: Reel spring shall be enclosed and fastened to reel drum with a reinforcing clip.
 6. Bearings and ratchet latch: Reel shall have permanently lubricated bearings and extra large ratchet latch with audible hose position lock.
 7. Hose covers and tubes: Chassis grease hose shall have Buna-N tube and Buna-N PVC cover. All other commodity hoses shall have Buna N nitrile tube with nitrile PVC cover.
 8. Delivery kits: Each commodity hose shall be fitted with the dispensing control as listed.
 - a. Compressed air (CA): Quick disconnect air coupler with necessary adapter fitting, Industrial Interchange Series 3/8 inch female
 - b. Gear oil (GO): Electronic in-line style english metered totalizing dispenser set to dispense(up to 5 GPM) in pints to 0.01 increments, Graco No. 255352
- D. Accessories:
1. Inlet hose kit: Each commodity reel shall be fitted with the inlet hose kit as listed.
 - a. Compressed air: 1/2 inch ID by 24 inches, medium pressure hose and fittings, rated for 2,000 PSI, Graco No. 218549, one each
 - b. Other commodities: 1/2 inch ID by 24 inches, medium pressure hose and fittings, rated for 2,000 PSI, Graco No. 218549, one each
 - c. Mounting bracket: Graco No. 204741
 - d. Mounting channel: Holds two reels, Graco No. 24A220; Six reel, Graco No. 24A222
 - e. Ball stop: Graco No. 218341, one for each reel

2. Identification labels: Each commodity reel shall have a 3/4 by 4-1/4 inch metal identification label indicating the commodity, attached adjacent to each hose guide arm roller assembly. Label kits including label and mounting hardware as listed for each commodity. Note: Label is listed before ().
 - a. Compressed air (CA): Graco No. 218675
 - b. Gear lube (GO): Graco No. 218672
 - E. Utility Requirements: Contractor shall provide process piping from product pumps to point of connection for each reel specified herein.
 - F. Finish: Durable enamel in manufacturer's standard color
- 2.06 REEL BANK (CA, GO)
Equipment Identifier: 7720
- A. Reel bank shall consist of one each (CA) reel and one each (GO) reel as delineated in part 2.05 REEL BANKS, GENERAL of this specification section.
 - B. Reference Sheet Q750 for details.
- 2.07 TANK, DOUBLE WALL, CUBE, 280 GALLON (GO, UGO)
Equipment Identifier: 7960
- A. Manufacturer's Reference:
 1. Prime manufacturer: Specifications are based on equipment identified herein by manufacturer's name and model to establish minimum acceptable standards of quality, features, performance, and construction.
 - a. Containment Solutions, Conroe, TX (936) 756-7731
 - b. Model: LC280DW (Reference Sheet EQS.500 for Details)
 2. Alternate manufacturers: *Contingent upon compliance with these specifications* and documentation requirements set forth in SUBMITTALS, equipment produced by other manufacturers, including the following, *may* be considered as equal.
 - a. Dynafab Corporation, Houston, TX (281) 590-5467
 - b. Highland Tank & Mfg. Co., Stoystown, PA (814) 893-5701
 - B. Capacities/Dimensions:
 1. Overall dimensions:
 - a. Length: 58 inches
 - b. Width: 34 inches
 - c. Height: 49 inches
 2. Capacity: 280 gallons

C. Features/Performance/Construction:

1. Above ground used oil collection and fluid storage systems shall be constructed in accordance with national, state, and locally recognized *Above Ground Storage Tank* standards, including: Uniform Fire Code, Nation Fire Protection Association 30, 30A, and 31, Underwriters Laboratory Standard 142-for single wall tanks.
2. The components of the system shall be assembled and tested at the factory and shall be covered under warranty.
3. The above ground double wall tank shall be designed and UL listed as an atmospheric tank with a maximum working pressure of one PSI.
4. The primary and secondary storage tanks shall have passed a proof of design hydrostatic pressure test of 25 PSI.
5. The above ground double wall tank shall be equipped with nine NPT openings including two for primary and secondary emergency venting as required by UL-142.
6. Primary tank enclosure:
 - a. Primary storage tank shall be rectangular in design and constructed with ASTM A-569 or A-36 carbon steel with continuous welds. Tank shall be equipped with lifting lugs.
 - b. Primary storage tank shall be constructed and pressure tested (minimum 3 to 5 PSI) in accordance with UL-142 standards and carry the appropriate marking.
 - c. Tank enclosure shall be supported by two 4-inch high steel support feet channels with internal anchoring holes to maintain ground clearance.
7. Secondary tank enclosure:
 - a. Secondary storage tank shall be a rectangular design constructed with ASTM A-569 or A-36 carbon steel with continuous welds and listed by Underwriters Laboratories as secondary containment.
 - b. Secondary enclosure shall provide a minimum of 110 percent secondary containment.
 - c. Secondary enclosure shall be equipped with a 2 inch monitoring port and a 4 or 6 or 8 inch emergency vent port as required by Underwriters Laboratories.
 - d. Secondary storage tank shall be constructed and pressure tested (minimum 3 to 5 PSI) in accordance with UL-142 standards and carry the appropriate marking.
8. Installation of tank shall include seismic bracing and anchoring to meet all local, state, and federal codes and provisions.

D. Accessories:

1. Double float tank gauge that is calibrated by gallons or inches (Scully or equal)
2. Venting:

-
- a. Primary: 4 inches NPT(M)
 - b. Secondary: 4 inches NPT(M)
- 3. Spill box: 7 gallon, welded to tank
 - 4. Used oil tanks:
 - a. Tank monitoring system with high level detection and alarm siren: Model No. 007, BJ Enterprises (800) 457-0749
 - b. Electrical requirements: 120 VAC, 20 A, standard grounded receptacle
- E. Finish: Durable enamel in manufacturer's standard color
- 2.08 RECEIVER, USED OIL, 25 GALLON
Equipment Identifier: 7999
- A. Manufacturer's Reference:
- 1. Prime manufacturer: Specifications are based on equipment identified herein by manufacturer's name and model to establish minimal acceptable standards of quality, features, performance, and construction.
 - a. Graco, Inc., Minneapolis, MN (612) 623-6000
 - b. Model: 238866
 - 2. Alternate manufacturers: *Contingent upon compliance with these specifications* and documentation requirements set forth in SUBMITTALS, equipment produced by other manufacturers, including the following, *may* be considered as equal.
 - a. Balcrank Corporation, Weaverville, NC (828) 645-4261
 - b. Lincoln, A Pentair Company, St. Louis, MO (314) 679-4200
- B. Capacities/Dimensions:
- 1. Capacity: 25 gallons
 - 2. Dimensions:
 - a. Length: 24 inches
 - b. Width: 24 inches
 - c. Height: 45 to 72 inches
 - d. Fluid inlet/inspection port size: 3 inch (76 millimeter) buttress
 - e. Fluid outlet fitting size: 3/4 inch NPT
 - f. Collection funnel size: 22 by 24 inches
- C. Features/Performance/Construction:
- 1. The unit shall be constructed of heavy duty, durable UV-stabilized polymer.
 - 2. The unit shall include a gravity feed drain valve and a quick disconnect method of suction-evacuation from the top of the unit.

3. The unit shall be mounted on semi-pneumatic, synthetic rubber wheels and polyurethane front casters.
 4. The unit shall contain a funnel assembly capable of extending to 72 inches.
 5. The unit shall be dent, rust, and corrosion resistant.
- D. Finish: UV-stabilized polymer complete with necessary markings to readily identify contents.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Coordinate location of rough-in work and utility stub-outs to assure match with equipment to be installed.
- B. Inspect equipment for damage from shipping and exposure to weather. Compare delivered equipment with packing lists and specifications to assure receipt of all equipment items and specified accessories.

3.02 INSTALLATION

- A. Perform work under direct supervision of Foreman of Construction Superintendent with authority to coordinate installation of scheduled equipment with Architect.
- B. Install equipment in accordance with plans, shop drawings, and manufacturer's instructions:
 1. Positioning: Place equipment in accordance with any noted special positioning requirements generally level (or slight slope as required by instructions), plumb, and at right angles to adjacent work.
 2. Fitting: Where field cutting or trimming is necessary, perform in a neat, accurate, professional manner without damaging equipment or adjacent work.
 3. Anchorage: Attach equipment as detailed or directed by Architect or designated representative. Installation fasteners shall be installed to avoid scratching or damaging adjacent surfaces.
 4. Air compressor and dryer system:
 - a. Install compressor unit on concrete foundation with sole plates and isolators. Level, grout, and bolt in place.
 - b. Make air cock and drain connection on horizontal casing.
 - c. Install line size ball valve and anti-return valve on compressor discharge.
 - d. Install replaceable cartridge type filter silencer of adequate capacity for each compressor.
 - e. Install condensate filter between compressor and dryer
 - f. Connect condensate drains to nearest floor drain.
 - g. Install valved bypass around air dryer. Factory insulate inlet and outlet connections.

- h. Install takeoffs to outlets from top of main with shutoff valve after takeoff.
- 5. Fluid storage tanks:
 - a. Tank shall be seismically braced and anchored to meet all local, state, and federal codes and provisions.
 - b. Used oil tank shall be vented to the outside of the building.
 - c. Remove support feet channels prior to final installation.
- C. Upon completion of work, finish surfaces shall be free of tool marks, scratches, blemishes, and stains.

3.03 TESTING

- A. After final connections are made and prior to authorizing payment, specified equipment shall be tested for compliance with specifications in the presence of the Architect or designated representative using acceptance procedures provided by the manufacturer.

3.04 CLEANUP

- A. Touch-up damage to painted finishes.
- B. Wipe and clean equipment of any oil, grease, and solvents, and make ready for use.
- C. Clean area around equipment installation and remove packing and installation debris from job site.
- D. Notify Architect or designated representative for acceptance inspection.

3.05 TRAINING

- A. Direct the technical representative to provide specified hours of training to designated Owner's maintenance personnel in operation and maintenance of the following equipment. Coordinate, with Owner, training schedule and list of personnel to be trained.
 - 1. 2161 Compressor, air, receiver mounted, 10 HP duplex; 1 hour (minimum)
 - 2. 2228 Dryer, air, refrigerated, 100 CFM; 1 hour (minimum)
 - 3. 7520 Pump, air piston, 10:1 ratio (GO) ; 1 hour (minimum)
 - 4. 7540 Pump, diaphragm, used fluid evacuation (UGO) ; 1 hour (minimum)
 - 5. 7700 Reel banks, general; 1 hour (minimum)
 - 6. 7720 Reel bank (CA, GO) ; 1 hour (minimum)
 - 7. 7960 Tank, double wall, cube, 280 gallon (GO, UGO) ; 1 hour (minimum)
 - 8. 7999 Receiver, used oil, 25 gallon; .5 hour (minimum)

- B. Obtain, from technical representative, a list of Owner's personnel trained in equipment operations and maintenance.

END OF SECTION 11 11 00

SECTION 11 11 26**VEHICLE WASH EQUIPMENT****PART 1 - GENERAL**

The General Provisions of the Contract, including General and Special Conditions and the requirements of Division 1, apply to the Work in this Section.

1.01 WORK INCLUDED**A. Equipment items as listed below by Equipment Identifier:**

1. 3720 Washer, high pressure/hot water, NG, 8 GPM (Ref. Part 2.01)
2. 3810 Washer, walk-around, vehicle (Ref. Part 2.02)
3. 3941 Recycling system, water (Ref. Part 2.03)

B. Installation:

1. General Contractor shall provide final connection of equipment to all utilities, including disconnects, floor, piping and conduit structures, with labor services and incidentals necessary for complete and operational equipment installation.
2. Manufacturer's Representative shall provide piping, wiring, and switching between equipment and roughed-in utilities and equipment connections. Installer is responsible for all system wiring and plumbing for a complete operation of wash equipment after installation.
3. General Contractor shall coordinate all washer features which interface with building systems that are required beyond the roughed-in utilities and equipment disconnects between wash equipment components with the manufacturer before construction of building and approval of the manufacturer's shop drawings.

1.02 QUALITY ASSURANCE**A. Experience:** Equipment shall be produced by a manufacturer of established reputation with a minimum of 5 years experience supplying specified equipment.**B. Manufacturer's Representative:**

1. Installation: Provide a qualified manufacturer's representative at site to supervise work related to equipment installation, check out, and start up.
2. Training: Provide technical representative to provide training to Owner's maintenance personnel in operation and maintenance of specified equipment.
3. Service: Provide a qualified manufacturer's representative to respond within 24 hours of a malfunction with the equipment during the warranty period.

1.03 SUBMITTALS

- A. Product Data: Submit Product Data in accordance with Division 1 of these specifications.
- B. Operations and Maintenance Manual:
 - 1. Submit Operations and Maintenance Manuals in accordance with Division 1- General Requirements of these specifications.
 - 2. Provide complete parts, operating, and maintenance manual covering equipment at time of installation.
 - 3. Description of system and components.
 - 4. Schematic diagrams of electrical, plumbing, and compressed air system.
 - 5. Manufacturer's printed operating instructions.
 - 6. Printed listing of periodic preventive maintenance items and recommended frequency to validate warranties. Failure to provide maintenance information will indicate that preventive maintenance is not a condition for validation of warranties.
- C. Shop Drawings: Submit Shop Drawings in accordance with Division 1.

1.04 PRODUCT SUBSTITUTIONS

- A. Follow requirements specified in Division 1 - General Requirements.
- B. Additional costs resulting from substitution of products other than those specified, by model number, including drawing changes and construction, will be at the expense of the Contractor.
- C. Substitution Approval: Prior to delivery or installation, submittals for each equipment item by Equipment Identifier shall be provided in accordance with Division 1 - General Requirements. Acceptance will be based on the technical requirements herein as determined by Owner and Architect.

1.05 WARRANTY

- A. Warranty work against defects in materials, functions and workmanship specified herein shall be good for 1 year from substantial completion.
- B. Warranty shall include materials and labor necessary to correct defects.
- C. Defects shall include, but not be limited to noisy, rough or substandard operation; loose, damaged, and missing parts; and abnormal deterioration of finish. Defects shall not include damage due to neglect, misuse, or situations resulting from non-performance of a manufacturer's recommended preventive maintenance schedule.
- D. Submit warranties in accordance with Division 1 - General Requirements of these specifications.
- E. All parts shall be readily available locally in the United States.

1.06 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver equipment in manufacturer's containers, appropriately packaged and/or crated for protection during domestic shipment and storage in humid and/or dusty conditions.
- B. Indelibly label all containers, including those contained in others, on outside with item description(s) per title and Equipment Identifier of this specification.
- C. Provide equipment and materials specified complete in one shipment for each equipment item. Split or partial shipments are not permissible.

1.07 LABELING

- A. Manufacturer shall securely attach in a prominent location, on each major item of equipment, a non-corrosive nameplate showing manufacturer's name, address, model number, serial number, and pertinent utility or operating data.
- B. Label all piping in vehicle wash and water reclaim systems as to its function and flow directions.
- C. All electrical equipment and materials shall be new and shall be listed by Underwriter's Laboratories, Inc. (UL) in categories for which standards have been set by that agency and labeled as such in the manufacturer's plant.

1.08 BUY AMERICA COMPLIANCE

- A. The Contractor shall comply with the applicable Buy America requirements set forth in 49 U.S.C. 5323(j) and the applicable regulations in 49 C.F.R. Part 661, as amended. If the Contractor procures any capital items with Federal funds, it is the Contractor's responsibility to obtain the Buy America certification required under such regulations.
- B. Reference Division 1 for Buy America compliance.

PART 2 - PRODUCTS

2.01 WASHER, HIGH PRESSURE/HOT WATER, NG, 8 GPM Equipment Identifier: 3720

- A. Manufacturer's Reference:
 - 1. Prime manufacturer: Specifications are based on equipment identified herein by manufacturer's name and model to establish minimum acceptable standards of quality, features, performance, and construction.
 - a. The Hotsy Corporation, Camas, WA (360) 833-1600
 - b. Model: 5735SS (stationary unit) with Accessories
 - 2. Alternate manufacturers: Contingent upon compliance with these specifications and documentation requirements set forth in SUBMITTALS, equipment produced by other manufacturers, including the following, may be considered as equal.

- a. Landa, Inc., Camas, WA (800) 547-8672
 - b. Alkota Cleaning Systems, Inc., Alcester, SD (605) 934-2222
- B. Capacities/Dimensions:
1. Operating pressure: 3,000 PSI
 2. Maximum discharge capacity: 7.8 GPM
 3. Overall dimensions:
 - a. Length: 51 inches
 - b. Width: 31 inches
 - c. Height: 63.4 inches
 4. Shipping weight: 1,260 pounds
- C. Features/Performance/Construction:
1. Burner: NG fired, 720,450 BTU/hr, AGA-listed gas controls, ring type with aspirating spuds, natural draft.
 2. All open flames and fire rings shall be mounted at minimum of 18 inches above the finished floor.
 3. Heating coil: vertically-fired; 1 inch OD, hydrostatic-pressure tested; 14,900 PSI burst-rated.
 4. Water pump: Triplex water pump with positive displacement, ceramic plungers, brass manifold, and oil bath crankcase.
 5. Fabrication: Welded angle iron frame shall have heavy gauge tank and cabinet.
 6. Piping: Supplier shall provide piping (schedule 80) from high-pressure wash unit to each trigger gun wand for a complete and operable system.
 7. Manufacturer shall supply all necessary soap system equipment including piping, fittings, distribution hose, and connections for a complete and operable soap distribution system.
 8. Shall control over run time, auto start/stop and shut down functionality.
 9. Trigger Gun Location: Manufacturer shall supply trigger gun, scabbard, hose reel, and push button starter at each location shown on drawings.
- D. Controls: Adjustable temperature controller, safety pressure relief valve, pressure switch, ON/OFF electric motor switch with overload protection, unloader, water heater switch, detergent valve and automatic, non-contaminating float valve.
- E. Accessories:
1. Trigger gun: Hotsy Model No. 87512350, one each per trigger gun location, two total
 2. 50 foot hose assembly: Hotsy Model No. 87391210, one each per trigger gun location, two total
 3. 36 inch wand: Hotsy Model No. 87112690, one each per trigger gun location, two total
 4. Nozzle: Hotsy Model No. 799021, one each per trigger gun location, two total

5. Quick coupler: Hotsy Model No. 844850, one each per trigger gun location, two total
6. Reel: 6 inch hose with 360 degree range, Hotsy Model No. 87504780, one each trigger gun location, two total
7. Soap solenoid and switch: Hotsy Model No. 89169880, one each per trigger gun location, two total
8. Remote starter: Hotsy Model No. 89169890, one each per trigger gun location, two total
9. Replacement nozzle: Pack of four, 4-1/2 millimeter with quick disconnect, Hotsy Model No. 87087140, one pack per trigger gun, two packs total
10. Draft diverter: Type "B", 12 inches, Hotsy Model No. 87177300, one each
11. Powershine Plus[®] detergent: 55 gallon container, Hotsy Model No. 89051800, one each
12. Hotsy scabbard for trigger gun, wall mounted: Hotsy Model No. 722B, one each per trigger gun location, two total

F. Utility Requirements:

1. Electrical: 460 VAC, 3 phase, 20 HP, 21 A
2. Plumbing:
 - a. Water: 3/4 inch to supply, 40 to 60 PSI, 7.8 GPM minimum (regulate water supply if greater than 60 PSI)
 - b. Natural gas: 3/4 inch NPT to supply 720,450 BTU at equipment
3. Mechanical:
 - a. Stack size: 10 inches with draft diverter

G. Finish: Durable enamel in manufacturer's standard color

2.02 WASHER, WALK-AROUND, VEHICLE
Equipment Identifier: 3810

A. Manufacturer's Reference:

1. Prime manufacturer: Specifications are based on equipment identified herein by manufacturer's name and model to establish minimum acceptable standards of quality, features, performance, and construction.
 - a. Bitimec, Greenwich, CT (203) 637-1900
 - b. Model: 626-LX
2. Alternate manufacturers: *Contingent upon compliance with these specifications* and documentation requirements set forth in SUBMITTALS, equipment produced by other manufacturers, including the following, *may* be considered as equal.
 - a. Awash System Corp., Niagara Falls, NY (800) 265-7405

B. Capacities/Dimensions:

1. Overall dimensions:
 - a. Length: 42 inches
 - b. Width: 48 inches
 - c. Height: 180 inches
 2. Capacity:
 - a. 110 gallons
 3. Weight:
 - a. Empty: 1,188 pounds (approximately)
 - b. Full: 2,112 pounds (approximately)
- C. Features/Performance/Construction:
1. The unit base and frame shall be manufactured of stainless steel and be void of all corrosion prone materials. All painted (powder coated) surfaces shall also be stainless steel.
 2. Drive System:
 - a. Battery: Industrial set of four in-line 6V deep cycle tubular.
 - b. Traction: 24V-DC motor operated drive wheel under base shall be centrally located and spring loaded for maximum operating ease, traction, and maneuverability.
 - c. Brush: 1KW (1.25HP) 24V electric DC Drive Motor
 3. Brush Inclination (tilt) System:
 - a. The unit shall be equipped with a 'brush only' inclination mechanism operated by 24V motor on a stainless steel guide. Inclination shall be push button controlled from both operating sides and have extra precise, smooth travel.
 - b. The unit shall be capable of continuous tilting throughout the entire wash cycle. When in a tilt position, the 'brush only' shall be tilted. The base and water shield must remain in the 90 degree upright position in order to guarantee stability and avoid machine frame from approaching/hitting/damaging the vehicle being washed.
 4. Brush:
 - a. Brush Fiber Type: Diamond/Star shaped, designed to channel water, to reduce friction and eliminate scratching. Diameter shall be 0.8 mm (other available diameter are 0.5 mm or 1.2 mm)
 - b. Brush fibers shall be feathered at the ends.
 - c. Brush fiber assembly shall be on a corrosion proof main shaft, riveted in replaceable segments max 12 inches high, in order to allow minimal replacement cost in case of partial damage.

-
5. Water Tank: The unit shall be totally autonomous and shall include a water tank of roll-molded-plastic.
 6. Wheels: Caster wheels shall be extreme service grade (8 inch of 10 inch size as required). Wheel bearings shall be sealed and turntable bearings shall include greasing apparatus for long life and smooth operation.
 7. Safety:
 - a. Automatic hands free stopping when operator releases controls.
 - b. Safety switches on brush, water pump, and detergent pump. Safety switches must include a release to be pushed for the switch to engage. Safety switches shall be able to be engaged with one single finger motion, but only deliberately.
 - c. The unit shall automatically reduce travel speed by 50 percent when brush rotation or water pump are engaged.
 8. Rinse: the unit shall have two sets of nozzles along the entire height of the brush, each capable of effecting a 180 degree spray pattern on vehicles.
- D. Controls: There shall be dual operating controls affording operator full unobstructed visibility for working in TWO directions. All machine power functions shall be operable from either set of controls.
- E. Utility Requirements:
1. Electrical: 120 VAC, 1 phase
- F. Finish: Durable enamel in manufacturer's standard color
- 2.03 RECYCLING SYSTEM, WATER
Equipment Identifier: 3941
- A. Manufacturer's Reference:
1. Prime manufacturer: Specifications are based on equipment identified herein by manufacturer's name and model to establish minimal acceptable standards of quality, features, performance, and construction.
 - a. Cascade Engineering Inc., Colorado Springs, CO (719) 684-8168
 - b. Model: WRS 32 with accessories
 2. Alternate manufacturers: *Contingent upon compliance with these specifications* and documentation requirements set forth in SUBMITTALS, equipment produced by other manufacturers *may* be considered as equal.
 - a. Landa, Inc., Camas, WA (360) 833-9100
 - b. Oil Trap Environmental, Tumwater, WA (800) 943-6495
- B. General Description:

1. System shall be integrated with functioning of the high-pressure washer within the wash equipment room, and the activities taking place in the adjacent wash bay.
2. System shall accept used wash-water and related materials via the catch basin in the wash bay and the truck wash. Used wash-water shall then, through a series of filters and treated with reagents to kill bacteria and odors, neutralize pH, be recycled and returned to a storage tank, awaiting re-use on demand by high-pressure washer.
3. System shall automatically refill the recycled water storage tank as demanded by use from the high-pressure washer. Any immediate demand that cannot be met by the system shall be made up for by the water supply of the facility.

C. Capacities/Dimensions:

1. Entire unit:
 - a. Width: 90 inches
 - b. Depth: 38 inches
 - c. Height: 51 inches
 - d. Weight: 800 pounds
 - e. Flow rate: 8 gallons per minute (12,000 gallons per day)
 - f. Makeup water: 100 PSI maximum pressure
 - g. Coagulant Tank: 120 gallons
 - h. Separator tank: 120 gallons
 - i. Storage tank: 120 gallons

D. Features/Performance/Construction:

1. Discharge pump shall have high head centrifugal pump with thermally protected motor. The pump shall provide pressurized water flow to pressure washer and other uses.
2. Inlet strainer shall be large size with stainless screen in corrosion resistant plastic housing.
3. Filter system shall be two 20 inch long 20 micron filter cartridges for final polishing.
4. Sludge collection system shall be three large, disposable fabric socks.
5. Storage tanks shall be polypropylene unitized construction.
6. Oil-water separator shall possess an oil skimmer for surface removal of oils directly to a waste-oil container.
7. Unit shall be constructed about a steel platform frame.
8. Recycle feed pump shall be self priming centrifugal cast iron with thermally protected motor. Pump shall be controlled with a float switch in the collection pit. Suction line strainer and foot valve shall be included.
9. Piping between all tanks shall be schedule 80 PVC piping.
10. System shall possess a sludge disposal system for the collection of solid wastes. Wastewater from this system shall flow directly back into the catch basin.
11. Reagent metering pumps shall be mounted in a fiberglass enclosure and include the following pumps:

- a. Electronic controlled diaphragm pumps with stroke rate and stroke length controls.
 - b. Automatic degassing head on oxidizer and pH adjust pump.
 - c. Coagulant pump with manual bleed.
12. Manufacturer shall supply all necessary system requirements including piping, fittings, distribution hose, and connections for a complete and operable wash-water recycling and re-distribution system.
- E. Controls:
1. Controls shall be unit mounted within a waterproof NEMA 4 rated enclosure. Control panel shall monitor and control the filtering, re-circulating, and sludge-dumping functions. Operational lights and heavy-duty switches shall accompany each control panel function, and controls shall be clearly labeled.
 2. Switches shall include power, feed pump, coagulant pump, oxidizer pump, pH adjuster pump, makeup water, and manual drain.
 3. Controller for pH shall have a digital display.
- F. Accessories:
1. Oil skimmer system: No. OS-3-E-L
 2. Ozone treatment: No. OZ 20 Ozone Generator System
 3. Graduated reagent containers:
 - a. Cascade aqua balance down kit: No. 1604
 - b. Cascade oxipower kit: No. 1605
 - c. Cascade coagulant 721 55 gallons with drum: No. 1202
 4. Additional oxidizer injector for the truck wash pit.
- G. Utility Requirements:
1. Electrical: 120 VAC, 1 phase, 15 A
 - a. Recycle feed pump: 1/2 HP
 - b. Discharge pump: 1/2 HP
 2. Plumbing:
 - a. Machine inlet: 1 1/2 inch NPT
 - b. Treated water outlet: 3/4 inch NPT
 - c. Drain line: 1 inch NPT
 - d. Make up water: 1/2 inch NPT
- H. Finish:
1. Steel frame: Hot dip galvanized. Owner's choice of manufacturer's supplied colors.

PART 3 - EXECUTION**3.01 INSPECTION**

- A. Coordinate location of rough-in work and utility stub-outs to assure match with equipment to be installed.
- B. Inspect delivered equipment for damage from shipping and exposure to weather. Compare delivered equipment with packing lists and specifications to assure receipt of all equipment items and specified accessories.
- C. Report in writing to the Architect, any damaged, missing or incomplete scheduled equipment, and improper rough-in work or utility stub-outs.

3.02 INSTALLATION

- A. Manufacturer's representative shall be responsible for complete operational equipment installation.
- B. Perform work under direct supervision of Foreman of Construction Superintendent with authority to coordinate installation of scheduled equipment with Architect or designated representative.
- C. Install equipment in accordance with plans, shop drawings, and manufacturer's instructions:
 - 1. Positioning: Place equipment in accordance with any noted special positioning requirements generally level (or slight slope as required by instructions), plumb, and at right angles to adjacent work.
 - 2. Fitting: Where field cutting or trimming is necessary, perform in a neat, accurate, professional manner without damaging equipment or adjacent work.
 - 3. Anchorage: Attach equipment as directed by Architect or designated representative. Installation fasteners shall be installed to avoid scratching or damaging adjacent surfaces.
 - 4. Upon completion of work, finish surfaces shall be free of tool marks, scratches, blemishes, and stains.
- D. Manufacturer shall provide an initial fill of all soap and solution tanks with the recommended brand of chemicals. A list of all recommended chemicals shall be provided to the owner.

3.03 TESTING

- A. After final connections are made and prior to authorizing payment, specified equipment shall be tested for compliance with specification in the presence of the Architect or designated representative using acceptance procedures provided by the manufacturer.
- B. Equipment shall not damage vehicles, including mirrors, windshield wipers and windows, or equipment itself.

- C. Malfunctions during testing shall be corrected within 5 days and re-tested. Malfunctions during second testing shall be corrected within 5 days and re-tested.
- D. Inadequate Performance: If equipment fails third test, Owner may elect to have all specified Equipment removed from site at no cost or obligation to Owner.
- E. All damage to the machine that is incurred as a result of the test shall be the responsibility of the manufacturer/supplier.

3.04 CLEANUP

- A. Touch-up damage to painted finishes.
- B. Wipe and clean equipment of any oil, grease and solvents, and make ready for use.
- C. Clean area around equipment installation and remove packing or installation debris from job site.
- D. Notify Architect or designated representative for acceptance inspection.

3.05 TRAINING

- A. Direct the technical representative to provide specified hours of training to designated Owner's maintenance personnel in *operation and maintenance* of the following equipment. Coordinate, with Owner, training schedule and list of personnel to be trained.
 - 1. 3720 Washer, high pressure, hot water, NG, 8 GPM; 2 hours (minimum)
 - 2. 3810 Washer, walk-around, vehicle; 4 hours (minimum)
 - 3. 3941 Recycling system, water; 2 hours (minimum)
- B. Obtain, from technical representative, a list of Owner's personnel trained in equipment operations and maintenance.

END OF SECTION 11 11 26

SECTION 11 11 29**SHOP EQUIPMENT****PART 1 - GENERAL**

The General Provisions of the Contract, including General and Special Conditions and the requirements of Division 1, apply to the Work in this Section.

1.01 WORK INCLUDED

- A. Equipment items as listed below by Equipment Identifier:
 - 1. 2090 Buffer/grinder, 10 inches, with dust collector (Ref. Part 2.01)
 - 2. 2191 Crimper, fittings/hose, electric/hydraulic (Ref. Part 2.02)
 - 3. 2220 Drill press, variable speed, 20 inches (Ref. Part 2.03)
 - 4. 2832 Vise, swivel base, 5 inches (Ref. Part 2.04)
 - 5. 3085 Cabinet, abrasive blast, with dust collector (Ref. Part 2.05)
 - 6. 5404 Forklift, electric, 4,000 pounds (Ref. Part 2.06)
 - 7. 5909 Cart, sanding (Ref. Part 2.07)
- B. Roughing-in, installation of equipment, and final connection of utilities, with labor, services, and incidentals necessary for complete and operational equipment installation.
- C. Piping, wiring, and switching between equipment and utilities.

1.02 QUALITY ASSURANCE

- A. Equipment shall be produced by a manufacturer of established reputation with a minimum of five years experience supplying specified equipment.
- B. Manufacturer's Representative:
 - 1. Installation: Provide a qualified manufacturer's representative at site to supervise work related to equipment installation, check out, and start up.
 - 2. Training: Provide technical representative to provide training to Owner's maintenance personnel in operation and maintenance of specified equipment.

1.03 SUBMITTALS

- A. Product Data:
 - 1. Submit Product Data in accordance with Division 1 - General Requirements of these specifications.
 - 2. Restrict submitted material to pertinent data. For instance, do not include manufacturer's complete catalog when pertinent information is contained on a single page.
- B. Operations and Maintenance Manual:

1. Submit Operations and Maintenance Manuals in accordance with Division 1- General Requirements of these specifications.
 2. Provide complete parts, operating, and maintenance manual covering equipment at time of installation.
 3. Description of system and components.
 4. Schematic diagrams of electrical, plumbing, and compressed air system.
 5. Manufacturer's printed operating instructions.
 6. Printed listing of periodic preventive maintenance items and recommended frequency to validate warranties. Failure to provide maintenance information will indicate that preventive maintenance is not a condition for validation of warranties.
- C. Shop Drawings:
1. Submit Shop Drawings in accordance with of Division 1 - General Requirements of these specifications.
 2. Submit site specific installation drawings and procedures.

1.04 PRODUCT SUBSTITUTIONS

- A. Follow requirements specified in Division 1 - General Requirements.
- B. Additional costs resulting from substitution of products other than those specified, by model number, including drawing changes and construction, will be at the expense of the Contractor.
- C. Substitution Approval: Prior to delivery or installation, submittals for each equipment item by Equipment Identifier shall be provided in accordance with Division 1 - General Requirements. Acceptance will be based on the technical requirements herein as determined by Owner and Architect.

1.05 WARRANTY

- A. Warrant work specified herein for one year from substantial completion against defects in materials, functions, and workmanship.
- B. Warranty shall include materials and labor necessary to correct defects.
- C. Defects shall include, but not be limited to noisy, rough or substandard operation; loose, damaged, and missing parts; and abnormal deterioration of finish.
- D. Submit warranties in accordance with Division 1 - General Requirements of these specifications.
- E. All parts shall be readily available locally in the United States.

1.06 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver equipment in manufacturer's containers, appropriately packaged and/or crated for protection during domestic shipment and storage in humid and/or dusty conditions.

- B. Indelibly label all containers, including those contained in others, on outside with item description(s) per title and Equipment Identifier of this specification.
- C. Provide equipment and materials specified complete in one shipment for each equipment item. Split or partial shipments are not permissible.

1.07 LABELING

- A. Manufacturer shall securely attach in a prominent location, on each major item of equipment, a non-corrosive nameplate showing manufacturer's name, address, model number, serial number, and pertinent utility or operating data.
- B. All electrical equipment and materials shall be new and shall be listed by Underwriter's Laboratories, Inc. (UL) in categories for which standards have been set by that agency and labeled as such in the manufacturer's plant.

1.08 BUY AMERICA COMPLIANCE

- A. The Contractor shall comply with the applicable Buy America requirements set forth in 49 U.S.C. 5323(j) and the applicable regulations in 49 C.F.R. Part 661, as amended. If the Contractor procures any capital items with Federal funds, it is the Contractor's responsibility to obtain the Buy America certification required under such regulations.
- B. Reference Division 1 for Buy America provisions.

PART 2 - PRODUCTS

2.01 BUFFER/GRINDER, 10 INCHES, WITH DUST COLLECTOR Equipment Identifier: 2090

- A. Manufacturer's Reference:
 - 1. Prime manufacturer: Specifications are based on equipment identified herein by manufacturer's name and model to establish minimal acceptable standards of quality, features, performance, and construction.
 - a. Cincinnati Electrical Tool, Inc., Cleves, OH (513) 941-5000
 - b. Model: 602-201-8 with Accessories
 - 2. Alternate manufacturers: *Contingent upon compliance with these specifications* and documentation requirements set forth in SUBMITTALS, equipment produced by other manufacturers, including the following, *may* be considered as equal.
 - a. Delta Machinery, Jackson, TN (800) 223-7278
 - b. Baldor, Fort Smith, AR (501) 646-4711
- B. Capacities/Dimensions:
 - 1. Motor:

-
- a. Grinder: 1,800 RPM
 - b. Fan: 3,600 RPM
2. Wheel(s):
 - a. Diameter: 10 inches
 - b. Thickness: 1-1/4 inch
 - c. Bore: 7/8 inch
 3. Distance between wheels: 17-5/8 inches
 4. Height to center of spindle: 40-3/8 inches
 5. Overall dimensions (nominal):
 - a. Width: 32 inches
 - b. Depth: 27 inches
 - c. Height: 70 inches
 6. Weight: 660 pounds
- C. Features/Performance/Construction:
1. Motor shall be totally enclosed, direct drive motor rated for continuous service, with permanently lubricated ball bearings.
 2. Wheel shall consist of one medium grit wheel and one general purpose wire wheel.
 3. Wheel guards shall be adjustable for wheel wear and shall include adjustable work rests and spark breakers.
 4. Light bulbs associated with illuminated eye shields shall be controlled by push button magnetic starter for buffer/grinder.
 5. Quenching pot shall be mounted on pedestal that supports grinder.
 6. Dust collector shall be enclosed with fan and motor in clean air chamber. External bag type dust collectors are not acceptable.
- D. Controls: Push button magnetic starter, Cincinnati No. 000-533 shall have "On/Off" push button switch; motor thermal overload and under voltage protection.
- E. Accessories:
1. Eye shields, Cincinnati No. 000-133, shall be an illuminated set of two per grinder.
- F. Utility Requirements:
1. Grinder motor: 460 VAC, 3 phase, 1 HP
 2. Fan motor: 460 VAC, 3 phase, 1 HP
- G. Finish: Durable enamel in manufacturer's standard color
- 2.02 CRIMPER, FITTINGS/HOSE, ELECTRIC/HYDRAULIC
Equipment Identifier: 2191

- A. Manufacturer's Reference:
1. Prime manufacturer: Specifications are based on equipment identified herein by manufacturer's name and model to establish acceptable standards of quality, performance, features, and construction.
 - a. The Gates Rubber Co., Denver, CO (303) 744-1911
 - b. Model: PC 707 with Accessories
 2. Alternate manufacturers; *Contingent upon compliance with these specifications* and documentation requirements set forth in SUBMITTALS, equipment produced by other manufacturers, including the following, *may* be considered as equal.
 - a. Weatherhead Dana Corporation, Toledo, OH (419) 891-2800
 - b. Parker Hannifin Corporation, Cleveland, OH (216) 896-3000
- B. Capacities/Dimensions:
1. Capacity: 3/16 inch inside dimension fiber braid through 1-1/4 inch wire hose
 2. Crimper dimensions, nominal:
 - a. Width: 12 inches
 - b. Depth: 13 inches
 - c. Height: 27 inches
 3. Overall Weight: 188 pounds
 4. Pump dimensions, nominal:
 - a. Length: 25 inches
 - b. Width: 12 inches
 - c. Height: 12 inches
 5. Pump operation pressure: 0 to 4,900 PSI
 6. Pump reservoir capacity: 10 cubic inches
 7. Pump weight: 70 pounds
- C. Features/Performance/Construction:
1. Pump shall be hydraulic operated pump.
 2. Pump shall be capable of delivering high volume of oil at low pressure for fast transversion.
 3. Crimper shall be able to crimp most hydraulic hoses from low pressure return lines to extremely high pressure spirals.
 4. Crimper shall crimp straight and bent tube stems, 45 degree and 90 degree block types.
- D. Accessories:
1. Die sets:

-
- a. 731, No. 7482-0931
 - b. 732, No. 7482-0932
 - c. 733, No. 7482-0933
 - d. 734, No. 7482-0934
 - e. 737, No. 7482-0937
 - 2. Power source: No. 7481-0023
 - E. Utility Requirements:
 - 1. Electrical: 120 VAC, 1 phase, 1 HP
 - F. Finish: Durable enamel in manufacturer's standard colors
- 2.03 DRILL PRESS, VARIABLE SPEED, 20 INCHES
Equipment Identifier: 2220
- A. Manufacturer's Reference:
 - 1. Prime manufacturer: Specifications are based on equipment identified herein by manufacturer's name and model to establish acceptable standards of quality, performance, features, and construction.
 - a. Clausing Industrial, Kalamazoo, MI (269) 345-7155
 - b. Model: 2277
 - 2. Alternate manufacturers: *Contingent upon compliance with these specifications* and documentation requirements set forth in SUBMITTALS, equipment produced by other manufacturers, including the following, *may* be considered as equal.
 - a. WMH Tool Group/Jet/Wilton, La Vergne, TN (615) 793-8900
 - b. Dake Machine Tools, Grand Haven, MI (800) 937-3253
 - B. Capacities/Dimensions:
 - 1. Speed: 150 to 2,000 RPM
 - 2. Overall dimensions, nominal:
 - a. Length: 22 inches
 - b. Width: 36 inches
 - c. Height: 66 inches
 - 3. Working dimensions:
 - a. Chuck to table: 33 inches
 - b. Chuck to base: 43 inches
 - 4. Table working surface:
 - a. Width: 22 inches
 - b. Depth: 19-1/2 inches

- c. Tilt range: 90 degrees to left and right
 - 5. Base working surface:
 - a. Width: 15-1/2 inches
 - b. Depth: 13 inches
 - 6. Capacities:
 - a. Spindle: 3MT, 1.74 inches
 - b. Spindle travel: 6-1/2 inches
 - c. Drill to center of circle: 20 inch diameter
 - d. Hand feed: 1.25 inch diameter
 - e. Column: Ground steel, 4 inches diameter and 1/2 inch wall thickness
- C. Features/Performance/Construction:
 - 1. Speed control shall permit positive speed changing while machine is running and hold speed setting constant under all load conditions.
 - 2. Belt drive shall remain aligned and automatically maintain full power transmission to spindle at all times.
 - 3. Work table shall have slots, side ledges, and machined front apron with mounting holes shall be provided for clamping of work with mounting holes.
 - 4. Tilt table shall have scale to provide accurate readings to 90 degrees right and left with index pin at level and 45 degrees left and right positions.
 - 5. Table lock shall have expanding bushing to provide rigid positioning of tables at any angle.
 - 6. Hand gear crank shall be provided for table adjustment.
 - 7. Safety features shall include self-ejecting chuck key and completely enclosed drive belt and pulleys.
 - 8. Motor shall be totally enclosed fan-cooled (TEFC):
 - a. Power cord shall have three-wire grounding cord with three-prong plug.
- D. Controls:
 - 1. Push-button switch shall include shrouded START button and protruding STOP button. Switches and other electrical controls shall meet applicable National Electrical Code requirements.
 - 2. Depth control shall be self-locking adjustable feed depth stop.
 - 3. Function controls shall provide manual speed selection and feed via knobbed spoked wheels.
- E. Accessories:
 - 1. Chuck: Clausing Model No. 1897
 - 2. Arbor adapter: Clausing Model No. 1898

- F. Utility Requirements: 460 VAC, 3 phase, 1.5 HP
- 2.04 VISE, COMBINATION, SWIVEL BASE, 5 INCHES
Equipment Identifier: 2832
- A. Manufacturer's Reference:
1. Prime manufacturer: Specifications are based on equipment identified herein by manufacturer's name and model to establish minimal acceptable standards of quality, features, performance, and construction.
 - a. WMH Tool Group/Jet/Wilton, La Vergne, TN (615) 793-8900
 - b. Model: 1755, stock number 63200
 2. Alternate manufacturers: *Contingent upon compliance with these specifications* and documentation requirements set forth in SUBMITTALS, equipment produced by other manufacturers, including the following, *may* be considered as equal.
 - a. Ridgid Tool Co., Elyria, OH (216) 323-5581
 - b. Milwaukee Tool and Equipment Co., Milwaukee, WI (414) 645-0200
- B. Capacities/Dimensions:
1. Jaw width: 5-1/2 inches
 2. Jaw opening: 5 inches
 3. Throat depth: 3-3/4 inches
 4. Overall dimensions, nominal:
 - a. Length: 17-1/4 inches
 - b. Width: 9 inches
 - c. Height: 9-1/2 inches
 5. Weight: 51.55 pounds
 6. Pipe capacity: 1/4 to 3 inches diameter
- C. Features/Performance/Construction:
1. Slide bar shall be machined steel and be oil port operable in machined channel.
 2. Base shall swivel 360 degrees and have locking device.
 3. Construction shall be semi-steel cast body and have hardened steel nut and screw.
 4. Jaws shall have replaceable facings.
- 2.05 CABINET, ABRASIVE BLAST, WITH DUST COLLECTOR
Equipment Identifier: 3085
- A. Manufacturer's Reference:

1. Prime manufacturer: Specifications are based on equipment identified herein by manufacturer's name and model to establish acceptable standards of quality, performance, features, and construction.
 - a. Trinity Tool Company, Fraser, MI (586) 296-5900
 - b. Model: Master 36/BP with Accessories
 2. Alternate manufacturers: *Contingent upon compliance with these specifications and documentation requirements set forth in SUBMITTALS, equipment produced by other manufacturers, including the following, may be considered as equal.*
 - a. Blast-It-All Division, Larry Hess and Associates, Inc., Salisbury, NC (704) 637-3300
 - b. Wheelabrator Corporation, La Grange, GA (706) 884-6884
- B. Capacities/Dimensions:
1. Cabinet:
 - a. Dimensions:
 - 1) Width: 38 inches
 - 2) Depth: 25 inches
 - 3) Height: 64 inches
 - b. Interior dimensions:
 - 1) Width: 36 inches
 - 2) Depth: 24 inches
 - 3) Height: 23 inches
 - c. Side door: 17 by 11 inches
 - d. Flip up top: 36 by 13 inches
 - e. Viewing window: 12 by 24 inches
 2. Dust collector:
 - a. Motor: 1,700 RPM
 - b. Vacuum rating: 100 CFM
 - c. Abrasive capacity: 2 gallons, minimum
 - d. Dimensions:
 - 1) Diameter: 15 inches
 - 2) Height: 54 inches
 3. Equipment dimensions including dust collector:
 - a. Width: 60 inches
 - b. Depth: 25 inches
 - c. Height: 64 inches

4. Weight: 300 pounds
- C. Features/Performance/Construction:
1. Media type: Unit shall utilize glass bead and sand for dry blast media.
 2. Cabinet: Blast cabinet shall be fabricated of 14 gauge welded steel.
 3. Gloves: Heavyweight rubber gloves shall be attached to 8 inch armhole ports, two each.
 4. Viewing window: Safety glass window shall be easily removable by loosening window frames.
 5. Lighting: Interior cabinet lighting shall be provided with fluorescent tubes.
 6. Air system: Unit shall be equipped with air pressure regulator and gauge.
 7. Doors:
 - a. Flip up top: Unit shall provide one flip up top door.
 - b. Side: Unit shall provide one side door.
 8. Dust collector:
 - a. Construction: Dust collector shall be fabricated of 14 gauge steel.
 - b. Motor: Unit shall be equipped with motor and impeller on clean air side.
 - c. Filter bags: Unit shall utilize filter bags with 8 square feet of total surface area.
 9. Orifice: Standard equipment for suction feed type media gun shall include a 5/16 inch ID orifice.
 10. Blow off: Unit shall be provided with a pushbutton controlled valve at the media gun.
 11. Nozzle: Nozzle and air jet shall be tungsten carbide.
 12. Nozzle mount bracket: Unit shall be provided with bracket for nozzle.
 13. Foot valve: Blasting control shall be provided by spring actuated 3 way air foot valve.
 14. Floor: Unit shall be equipped with 1/8 inch expanded steel recessed floor with a carbon screen cover.
 15. Air connection: Air connection shall be 3/8 inch female connection to regulator.
- D. Controls: ON/OFF toggle switch for lighting and dust collector. Electrical controls and switching shall meet all National Electrical Code requirements.
- E. Accessories:
1. Filter bags: Dust collector replacement filter bags, Trinco No. 2-000-30, six each
 2. Nozzle: 5/16 inch ID, Trinco No. 2-000-71, one each
- F. Utility Requirements:
1. Electrical: 120 VAC, 1-1/3 HP, 1.6 A
 2. Compressed air: 3/8 inch, 85 PSI at 30 CFM

G. Finish: Durable enamel in manufacturer's standard color

2.06 FORK LIFT, ELECTRIC, 4,000 POUNDS
Equipment Identifier: 5404

A. Manufacturer's Reference:

1. Prime manufacturer: Specifications are based on equipment identified herein by manufacturer's name and model to establish minimal acceptable standards of quality, features, performance, and construction.
 - a. Clark Material Handling Company, Lexington, KY (859) 422-6400
 - b. Model: NPR 20
2. Alternate manufacturers: *Contingent upon compliance with these specifications* and documentation requirements set forth in SUBMITTALS, equipment produced by other manufacturers, including the following, *may* be considered as equal.
 - a. Hyster Company, Danville, IL (252)561-7104
 - b. Mitsubishi Forklifts, Houston, TX (713) 365-1000

B. Capacities/Dimensions:

1. Rated capacity: 4,000 pounds
2. Power: 24/36 volt
3. Overall dimensions:
 - a. Width: 40-1/4 inches
 - b. Length: 70-1/4 inches
 - c. Height: 95 to 258 inches
 - d. Turning radius: 66-1/2 inches
4. Weight: 6,940 pounds
5. Mast dimensions/capacities:
 - a. 24 inch load center
 - b. Fork length: 48.1 inches

C. Features/Performance/Construction:

1. Unit shall contain a battery with 6 hour rate maximum.
2. Unit shall have urethane tires.
3. Unit shall have automatic, spring applied parking brake
4. Unit shall have hydraulic assist, variable steering.
5. Unit shall have a service brake consisting of a drum and shoe.
6. Drive motor and steer/auxiliary motor shall be controlled by transistor, infinite.

D. Utilities Requirements:

1. Electrical: 460 VAC, 3 phase, 30 A, provide dedicated circuit

2.07 CART, SANDING

Equipment Identifier: 5909

A. Manufacturer's Reference:

1. Prime manufacturer: Specifications are based on equipment identified herein by manufacturer's name and model to establish minimal acceptable standards of quality, features, performance, and construction.
 - a. U.S. Train Products, Marietta, GA (770) 953-9224
 - b. Model: USTP MSR 600 Mobile Sand Refilling System
2. Alternate manufacturers: *Contingent upon compliance with these specifications* and documentation requirements set forth in SUBMITTALS, equipment produced by other manufacturers, including the following, *may* be considered as equal.

B. Capacities/Dimensions:

1. Overall dimensions:
 - a. Width: 126 inches
 - b. Depth: 75 inches
 - c. Height: 44 inches

C. Features/Performance/Construction:

1. Multiple operating modes:
 - a. Automatic Refill-Cycle with "Auto-Shut-off"
 - b. Manual Refill-Cycle
 - c. Vehicle Reload Setup Cycle
2. Industrial onboard computer and system controller
3. Heavy duty command and operation controls
4. Wireless communication interface (IP) to upload/download operating data
5. 600 liter sand container with certified filling pressure vessel
6. Heavy duty industrial vacuum, filtration and air compressor system
7. High-efficient onboard air compressor with reservoir
8. Sand filling pistol for dustless filling process
9. Sufficient to fill approximately 1000-1200 liters of brake sand during an 8 hour shift
10. Extra-wide tires for better yard operation
11. Welded constructed system housing and component enclosure

D. Accessories:

1. Shop battery charging station, Model No. USTP MSR-9001, one each
2. Bag slitting funnel, Model No. USTP MSR-1010, one each

- E. Utility Requirements:
 - 1. Electrical: 120 VAC, 1 phase, 30 amps, 60 hertz
- F. Finish: Durable enamel in manufacturer's standard color

PART 3 - EXECUTION

3.01 INSPECTION

- A. Coordinate location of rough-in work and utility stub-outs to assure match with equipment to be installed.
- B. Inspect delivered equipment for damage from shipping and exposure to weather.
- C. Compare delivered equipment with packing lists and specifications to assure receipt of all equipment items.

3.02 INSTALLATION

- A. Perform work under direct supervision of Foreman of Construction Superintendent with authority to coordinate installation of scheduled equipment with Architect or designated representative.
- B. Install equipment in accordance with plans, shop drawings, and manufacturer's instructions:
 - 1. Positioning: Place equipment in accordance with any noted special positioning requirements generally level (or slight slope as required by instructions), plumb, and at right angles to adjacent work.
 - 2. Fitting: Where field cutting or trimming is necessary, perform in a neat, accurate, professional manner without damaging equipment or adjacent work.
 - 3. Anchorage: Attach equipment as directed by Architect or designated representative. Installation fasteners shall be installed to avoid scratching or damaging adjacent surfaces.
- C. Upon completion of work, finish surfaces shall be free of tool marks, scratches, blemishes, and stains.

3.03 TESTING

- A. After final connections are made and prior to authorizing payment, specified equipment shall be tested for compliance with specifications in the presence of the Architect or designated representative using acceptance procedures provided by the manufacturer.

3.04 CLEANUP

- A. Touch-up damage to painted finishes.

- B. Wipe and clean equipment of any oil, grease, and solvents, and make ready for use.
- C. Clean area around equipment installation and remove packing and installation debris from job site.
- D. Notify Architect or designated representative for acceptance inspection.

3.05 TRAINING

- A. Direct the technical representative to provide specified hours of training to designated Owner's maintenance personnel in operation and maintenance of the following equipment. Coordinate, with Owner, training schedule and list of personnel to be trained.
 - 1. 2090 Buffer/grinder, 10 inches, with dust collector; .5 hours (minimum)
 - 2. 2191 Crimper, fittings/hose, electric/hydraulic; .5 hours (minimum)
 - 3. 2220 Drill press, variable speed, 20 inches; .5 hours (minimum)
 - 4. 3085 Cabinet, abrasive blast, with dust collector; 1 hours (minimum)
 - 5. 5404 Forklift, electric, 4,000 pounds; 1 hours (minimum)
- B. Obtain, from technical representative, a list of Owner's personnel trained in equipment operations and maintenance.

END OF SECTION 11 11 29

SECTION 11 31 00**RESIDENTIAL APPLIANCES****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. This Section includes the following:
 - 1. Dishwashers.
 - 2. Refrigeration appliances
- B. Related Sections include the following:
 - 1. Division 6 Section "Interior Architectural Woodwork" for custom-made cabinets and plastic-laminate tops that receive residential appliances.
 - 2. Division 22 Section "Plumbing Piping" for water distribution piping, drainage and vent piping connections to residential appliances.
 - 3. Division 22 Section "Plumbing Fixtures" for kitchen sinks, and waste disposers.
 - 4. Division 26 electrical sections for services and connections to residential appliances.

1.03 SUBMITTALS

- A. Product Data: For each type of product indicated. Include operating characteristics, dimensions of individual appliances, and finishes for each appliance.
- B. Samples for Verification: For all products with factory-applied finishes, prepared on Samples of size indicated below.
 - 1. Size: 12 x 12 inches
- C. Appliance Schedule: For appliances. Use same designations indicated on Drawings.
- D. Manufacturer Certificates: Signed by manufacturers certifying that products comply with requirements.
- E. Product Test Reports: Based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency, for each product.
- F. Research/Evaluation Reports: For each product.
- G. Maintenance Data: For each product to include in maintenance manuals.
- H. Warranties: Special warranties specified in this Section.

1.04 QUALITY ASSURANCE

- A. **Manufacturer Qualifications:** A qualified manufacturer. Maintain, within 25 miles of Project site, a service center capable of providing training, parts, and emergency maintenance repairs.
- B. **Source Limitations:** Obtain residential appliances through one source from a single manufacture.
 - 1. To the greatest extent possible, provide appliances by a single manufacturer for entire Project.
- C. **Regulatory Requirements:** Comply with provisions of the following product certifications:
 - 1. **NFPA:** Provide electrical appliances listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
 - 2. **UL and NEMA:** Provide electrical components required as part of residential appliances that are listed and labeled by UL and that comply with applicable NEMA standards.
 - 3. **NAECA:** Provide residential appliances that comply with NAECA standards.
- D. **Regulatory Requirements, Accessibility:** Where residential appliances are indicated to comply with accessibility requirements, comply with the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA), Accessibility Guidelines for Buildings and Facilities (ADAAG)."
 - 1. **Operable Parts:** Provide controls with forward reach no higher than 48 inches above the floor, horizontal front reach no more than 25 inches, horizontal side reach no more than 24 inches, and that do not require tight grasping, pinching, or twisting of the wrist and that operate with a force of not more than 5 lbf.
- E. **AHAM Standards:** Provide appliances that comply with the following AHAM standards:
 - 1. **Dishwashers:** AHAM DW-DW1.
- F. **Energy Ratings:** Provide residential appliances that carry labels indicating energy-cost analysis (estimated annual operating costs) and efficiency information as required by the FTC Appliance Labeling Rule.
 - 1. Provide appliances that qualify for the EPA/DOE ENERGY STAR product labeling program.
- G. **Preinstallation Conference:** Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."

1.05 WARRANTY

- A. **Special Warranties:** Manufacturer's standard form in which manufacturer of each appliance specified agrees to repair or replace residential appliances or components that fail in materials or workmanship within specified warranty period.

1. Dishwasher: 10-year warranty for in-home service against deterioration of tub and door liner.
2. Refrigerator/Freezer, Sealed System: Full warranty including parts and labor for on-site service on the product.
 - a. Warranty Period for Sealed Refrigeration System: Five years from date of Substantial Completion.
 - b. Warranty Period for Other Components: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products specified.
 2. Products: Subject to compliance with requirements, provide one of the products specified.
 3. Basis-of-Design Product: The design for each residential appliance is based on the product named. Subject to compliance with requirements, provide either the named product or a comparable product by one of the other manufacturers specified.

2.02 CLEANING APPLIANCES

- A. Dishwasher
 1. Basis-of-Design Product: Subject to compliance with requirements, provide Model #: GSD4060DSS by General Electric Company or comparable product by one of the following:
 - a. BOSCH, BSH Home Appliances Corporation;.
 - b. KitchenAid.
 - c. Whirlpool Corporation.
 2. Type: Under the counter, operable at water pressures from 15 to 120 psi.
 3. Dimensions: 24 inches wide x depth indicated on Drawings.
 4. Tub and Door Liner: Manufacturer's standard.
 - a. Detergent Dispenser: Sealed detergent and automatic rinsing-aid dispensers in door liner.
 5. Rack System: Nylon-coated sliding dish racks, with removable cutlery basket.
 6. Operation: Four wash cycles with hot-air and heat-off drying cycle options.
 7. Controls: Solid-state, electronic, press-to-start type.
 8. Front Panel: Manufacturer's standard.
 9. Appliance Color: Stainless Steel.
 10. Standard features include the following:

- a. Waste food disposer.
- b. Self-cleaning food-filter system.
- c. Hot-water booster heater for 160 deg F wash water with incoming water at 100 deg F.

11. Capacity:

- a. Place Settings: Eight .
- b. Water Consumption for Full Load: 3.2 gal.

2.03 REFRIGERATOR/FREEZERS

A. Refrigerator/Freezer Two-door refrigerator/freezer with freezer on top and complying with AHAM HRF-1.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Model #: GTZ18GCESS by General Electric Company or comparable product by one of the following:
 - a. BOSCH, BSH Home Appliances Corporation;.
 - b. KitchenAid.
 - c. Whirlpool Corporation.
2. Type: Freestanding.
3. Dimensions:
 - a. Width: 30 inches
 - b. Depth: 32-3/8 inches.
 - c. Height: 66-7/8 inches
4. Storage Capacity:
 - a. Refrigeration Compartment Volume: 13.89 cu. ft.
 - b. Freezer Volume: 4.22 cu. ft.
 - c. Shelf Area: Two adjustable glass shelves.
5. General Features:
 - a. Built-in water filtration system.
 - b. Dual refrigeration systems.
 - c. Separate temperature controls for each compartment.
6. Refrigerator Features:
 - a. Interior light in refrigeration compartment.
 - b. Compartment Storage: 3 total clear storage drawers, 2 with humidity control.
 - c. Door Storage: Modular compartments.
7. Freezer Features: One freezer compartment.
 - a. Automatic defrost.
 - b. Interior light in freezer compartment.

- c. Automatic icemaker and storage bin.
- 8. Energy Performance, ENERGY STAR: Provide appliances that qualify for the EPA/DOE ENERGY STAR product labeling program.
- 9. Appliance Color/Finish: Stainless steel.

1.01 FINISHES, GENERAL

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Finish: Provide appliances with manufacturer's standard finish as selected by Architect.

PART 2 - EXECUTION

2.01 EXAMINATION

- A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of work.
- B. Examine roughing-in for piping systems to verify actual locations of piping connections before equipment installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

2.02 INSTALLATION, GENERAL

- A. General: Comply with manufacturer's written instructions.
- B. Utilities: Refer to Divisions 22 and 26 for plumbing and electrical requirements.

2.03 CLEANING AND PROTECTION

- A. Test each item of residential appliances to verify proper operation. Make necessary adjustments.
- B. Verify that accessories required have been furnished and installed.
- C. Remove packing material from residential appliances and leave units in clean condition, ready for operation.

2.04 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain residential appliances. Refer to Division 1 Section "Closeout Procedures."

END OF SECTION 11 31 00

SECTION 12 24 13
ROLLER WINDOW SHADES**PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY**A. Section Includes:**

- 1. Manually operated roller shades with single rollers.

B. Related Requirements:

- 1. Section 06 10 53 "Miscellaneous Rough Carpentry" for wood blocking and grounds for mounting roller shades and accessories.
- 2. Section 07 92 00 "Joint Sealants" for sealing the perimeters of installation accessories for light-blocking shades with a sealant.

1.03 SUBMITTALS**A. Product Data:** For each type of product.

- 1. Include styles, material descriptions, construction details, dimensions of individual components and profiles, features, finishes, and operating instructions for roller shades.

B. Shop Drawings: Show fabrication and installation details for roller shades, including shadeband materials, their orientation to rollers, and their seam and batten locations.**C. Samples:** For each exposed product and for each color and texture specified, **10 inches** long.**D. Samples for Initial Selection:** For each type and color of shadeband material.

- 1. Include Samples of accessories involving color selection.

E. Samples for Verification: For each type of roller shade.

- 1. Shadeband Material: Not less than **10 inches** square. Mark inside face of material if applicable.
- 2. Roller Shade: Full-size operating unit, not less than **16 inches** wide by **36 inches** long for each type of roller shade indicated.
- 3. Installation Accessories: Full-size unit, not less than **10 inches** long.

F. Roller-Shade Schedule: Use same designations indicated on Drawings.**G. Qualification Data:** For Installer.**H. Product Certificates:** For each type of shadeband material, signed by product manufacturer.

- I. Product Test Reports: For each type of shadeband material, for tests performed by manufacturer and witnessed by a qualified testing agency
- J. Maintenance Data: For roller shades to include in maintenance manuals.

1.04 QUALITY ASSURANCE

- A. Installer Qualifications: Fabricator of products.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver roller shades in factory packages, marked with manufacturer, product name, and location of installation using same designations indicated on Drawings.

1.06 FIELD CONDITIONS

- A. Environmental Limitations: Do not install roller shades until construction and finish work in spaces, including painting, is complete and dry and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
- B. Field Measurements: Where roller shades are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Allow clearances for operating hardware of operable glazed units through entire operating range. Notify Architect of installation conditions that vary from Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide EcoVeil shades by MechoShade Systems, Inc. or comparable product by one of the following:
 - 1. Draper Inc.
 - 2. Hunter Douglas Contract.
 - 3. Lutron Electronics Co., Inc.
 - 4. Nysan Solar Control Inc.; Hunter Douglas Company.
- B. Source Limitations: Obtain roller shades from single source from single manufacturer.

2.02 MANUALLY OPERATED SHADES WITH SINGLE ROLLERS

- A. Chain-and-Clutch Operating Mechanisms: With continuous-loop bead chain and clutch that stops shade movement when bead chain is released; permanently adjusted and lubricated.
 - 1. Bead Chains: Manufacturer's standard.
 - a. Loop Length: Full length of roller shade.
 - b. Limit Stops: Provide upper and lower ball stops.
 - c. Chain-Retainer Type: Clip, jamb mount
- B. Rollers: Extruded-aluminum tubes of diameters and wall thicknesses required to accommodate operating mechanisms and weights and widths of shadebands

indicated without deflection. Provide with permanently lubricated drive-end assemblies and idle-end assemblies designed to facilitate removal of shadebands for service.

1. Roller Drive-End Location: Right side of inside face of shade.
 2. Direction of Shadeband Roll: Regular, from back of roller.
 3. Shadeband-to-Roller Attachment: Manufacturer's standard method.
- C. Mounting Hardware: Brackets or endcaps, corrosion resistant and compatible with roller assembly, operating mechanism, installation accessories, and mounting location and conditions indicated.
- D. Roller-Coupling Assemblies: Coordinated with operating mechanism and designed to join up to three inline rollers into a multiband shade that is operated by one roller drive-end assembly.
- E. Shadebands:
1. Shadeband Material: Light-filtering fabric.
 2. Shadeband Bottom (Hem) Bar: Steel or extruded aluminum.
 - a. Type: Enclosed in sealed pocket of shadeband material.
 - b. Color and Finish: As indicated on Finish Legend.
- F. Installation Accessories:
1. Front Fascia: Aluminum extrusion that conceals front and underside of roller and operating mechanism and attaches to roller endcaps without exposed fasteners.
 - a. Shape: L-shaped.
 - b. Height: Manufacturer's standard height required to conceal roller and shadeband when shade is fully open, but not less than 4 inches.
 2. Exposed Headbox: Rectangular, extruded-aluminum enclosure including front fascia, top and back covers, endcaps, and removable bottom closure.
 - a. Height: Manufacturer's standard height required to enclose roller and shadeband when shade is fully open, but not less than 4 inches.
 3. Endcap Covers: To cover exposed endcaps.
 4. Recessed Shade Pocket: Rectangular, extruded-aluminum enclosure designed for recessed ceiling installation; with front, top, and back formed as one piece, end plates, and removable bottom closure panel.
 - a. Height: Manufacturer's standard height required to enclose roller and shadeband when shade is fully open, but not less than height indicated on Drawings.
 - b. Provide pocket with lip at lower edge to support acoustical ceiling panel.
 5. Installation Accessories Color and Finish: As selected from manufacturer's full range.

2.03 SHADEBAND MATERIALS

- A. Shadeband Material Flame-Resistance Rating: Comply with NFPA 701. Testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

- B. Light-Filtering Fabric: Woven fabric, stain and fade resistant.
 - 1. Source: Roller-shade manufacturer.
 - 2. Type: Woven PVC-coated fiberglass and PVC-coated polyester
 - 3. Weave: Mesh.
 - 4. Orientation on Shadeband: Railroaded
 - 5. Openness Factor: 10 percent.
 - 6. Color: As indicated on Finish Legend.
- C. Light-Blocking Fabric: Opaque fabric, stain and fade resistant.
 - 1. Source: Roller-shade manufacturer.
 - 2. Type: Fiberglass textile with PVC film bonded to both sides.
 - 3. Orientation on Shadeband: Railroaded.
 - 4. Features: Washable.
 - 5. Color: As indicated on Finish Legend

2.04 ROLLER-SHADE FABRICATION

- A. Product Safety Standard: Fabricate roller shades to comply with WCMA A 100.1, including requirements for flexible, chain-loop devices; lead content of components; and warning labels.
- B. Unit Sizes: Fabricate units in sizes to fill window and other openings as follows, measured at 74 deg F:
 - 1. Between (Inside) Jamb Installation: Width equal to jamb-to-jamb dimension of opening in which shade is installed less 1/4 inch per side or 1/2-inch total, plus or minus 1/8 inch. Length equal to head-to-sill or -floor dimension of opening in which shade is installed less 1/4 inch, plus or minus 1/8 inch.
 - 2. Outside of Jamb Installation: Width and length as indicated, with terminations between shades of end-to-end installations at centerlines of mullion or other defined vertical separations between openings.
- C. Shadeband Fabrication: Fabricate shadebands without battens or seams to extent possible except as follows:
 - 1. Railroaded Materials: Railroad material where material roll width is less than the required width of shadeband and where indicated. Provide battens and seams as required by railroaded material to produce shadebands with full roll-width panel(s) plus, if required, one partial roll-width panel located at top of shadeband.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, operational clearances, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 ROLLER-SHADE INSTALLATION

- A. Install roller shades level, plumb, and aligned with adjacent units according to manufacturer's written instructions.

1. Opaque Shadebands: Located so shadeband is not closer than 2 inches to interior face of glass. Allow clearances for window operation hardware.

3.03 ADJUSTING

- A. Adjust and balance roller shades to operate smoothly, easily, safely, and free from binding or malfunction throughout entire operational range.

3.04 CLEANING AND PROTECTION

- A. Clean roller-shade surfaces after installation, according to manufacturer's written instructions.
- B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that roller shades are without damage or deterioration at time of Substantial Completion.
- C. Replace damaged roller shades that cannot be repaired, in a manner approved by Architect, before time of Substantial Completion.

END OF SECTION 12 24 13

SECTION 12 36 16**STAINLESS STEEL COUNTERTOPS****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section Includes:
 - 1. Stainless-steel countertops
- B. Applications: Refer to Drawings for locations.
- C. Related Sections include the following:
 - 1. Division 06 Section "Miscellaneous Carpentry" for wood blocking for anchoring countertops.
 - 2. Division 06 Section "Interior Architectural Woodwork" for plastic-laminate and solid-surfacing material countertops.
 - 3. Division 09 Section "Gypsum Plaster" for reinforcements in metal-framed plaster partitions for anchoring countertops.
 - 4. Division 09 Section "Gypsum Board Assemblies" for reinforcements in metal-framed gypsum board partitions for anchoring countertops

1.03 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For metal countertops Include plans, elevations, sections, details, and attachments to other work.
 - 1. Indicate locations of blocking and reinforcements required for installing countertops
 - 2. Indicate hardware locations.
 - 3. Indicate locations of and clearances from adjacent walls, doors, windows, other building components, and equipment.
 - 4. Indicate locations of seams in stainless-steel countertops.
- C. Samples for Initial Selection: For factory-applied finishes.
- D. Samples for Verification: Full-size units of each type of exposed hardware indicated.

1.04 QUALITY ASSURANCE

- A. Source Limitations: Obtain countertopsthrough one source from a single manufacturer.
- B. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Protect finished surfaces during handling and installation with protective covering of polyethylene film or other suitable material.

1.06 COORDINATION

- A. Coordinate layout and installation of framing and reinforcements for support of countertops

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Stainless-Steel Sheet: ASTM A 666, Type 304, stretcher-leveled standard of flatness.
- B. Minimum Nominal Stainless-Steel Thicknesses for countertops:
 - 1. Countertops: 0.0500 inch.
 - 2. Shelves: 0.0375 inch except 0.0500 inch for unreinforced shelves more than 36 inches long.
 - 3. Miscellaneous Components: 0.0375 inch minimum.

2.02 FABRICATION

- A. General: Assemble and finish units at point of manufacture. Perform assembly on precision jigs to provide units that are square. Reinforce units with angles, gussets, and channels.
- B. Adjustable Shelves: Front, back, and ends formed down, with edges returned horizontally at front and back to form reinforcing channels.
- C. Filler Strips: Provide as needed to close spaces between cabinets and walls, ceilings, and indicated equipment. Fabricate from same material and with same finish as countertops with hemmed or flanged edges.

2.03 STAINLESS-STEEL FINISH

- A. Grind and polish surfaces to produce uniform, directionally textured finish, free of cross scratches and matching No. 4 finish. Run grain with long dimension of each piece.
- B. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

2.04 STAINLESS-STEEL COUNTERTOPS

- A. Countertops: Provide units with smooth surfaces in uniform plane free of defects. Ease exposed edges and corners. Provide front and end overhang of 1 inch over base cabinets.
 - 1. Stainless-Steel Sheet: ASTM A 666, Type [304] [316], not less than 0.0625-inch nominal thickness, with No. 4 satin finish.
 - 2. Extend top down 1 inch at edges with a 1/2-inch return flange under frame. Apply heavy coating of heat-resistant, sound-deadening mastic to undersurface.
 - 3. Form backsplash coved to and integral with top surface.
 - 4. Provide rolled edge, unless otherwise indicated.

5. Provide raised (marine) edge around perimeter of countertops containing sinks; pitch two ways to sink to provide drainage without channeling or grooving.
 6. Reinforce underside of countertop with channels or use thicker metal sheet where necessary to insure rigidity without deflection.
 7. Weld shop-made joints, and grind and polish surfaces to produce uniform, directionally textured finish, free of cross scratches. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
 8. Where field-made joints are permitted, provide welded joints.
 9. Where field-made joints are required, provide hairline butt-joints mechanically bolted through continuous channels welded to underside at edges of joined ends. Keep field jointing to a minimum.
 10. Where stainless-steel sinks or cup sinks occur in stainless-steel countertops, factory weld into one integral unit, grind welds smooth, polish, passivate, and rinse.
- B. Shelves: Made from stainless-steel sheet, ASTM A 666, Type [304] [316], not less than 0.050-inch nominal thickness, with No. 4 satin finish. Fold [down] [up] front edge 3/4 inch; fold up back edge 3 inches. Provide integral stiffening brackets, formed by folding up ends 3/4 inch and welding to upturned [back edge] [front and back edges]. Weld shop-made joints, grind smooth, and finish.
- C. Sinks: Provide sizes indicated or metal medical casework manufacturer's closest standard size of equal or greater volume, as approved by Architect.
1. Stainless-Steel Sheet: ASTM A 666, Type [304] [316], not less than 0.050-inch nominal thickness. Fabricate with corners rounded and coved to at least 5/8-inch radius. Slope sink bottoms to outlet. Provide double-wall construction for sink partitions with top edge rounded to at least 1/2-inch diameter. Provide continuous butt-welded joints, grind smooth, and polish surfaces to produce nondirectional finish, free of scratches. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
 2. Provide factory punchings for fittings.
 3. Provide with stainless-steel strainers and tailpieces, NPS 1-1/2, unless otherwise indicated.
 4. Where indicated, provide stainless-steel overflow of standard beehive or open-top design with separate stainless-steel strainer. Height 2 inches less than sink depth.
 5. Apply 1/8-inch-thick coating of heat-resistant, sound-deadening mastic to undersink surfaces.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine areas, with Installer present, for compliance with requirements for installation tolerances, location of reinforcements, and other conditions affecting performance of metal medical casework.
1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION OF SHELVING

- A. Install level, plumb, and true; shim as required, using concealed shims. Where metal shelves abut other finished work, apply filler strips and scribe for accurate fit, with

fasteners concealed where practical.

- B. Install hardware uniformly and precisely

3.03 INSTALLATION OF COUNTERTOPS

- A. Abut top and edge surfaces in one true plane with flush hairline joints and with internal supports placed to prevent deflection. Locate joints only where shown on Shop Drawings.
- B. Field Jointing: Provide flush welded joints in tops. Grind and polish surfaces to produce uniform, directionally textured finish, free of cross scratches. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
- C. Field Jointing: Provide flush hairline joints in tops using adhesives and fasteners recommended by manufacturer. Prepare edges to be joined in shop so Project-site processing of top and edge surfaces is not required. Locate field-made joints only where indicated.
- D. Fastening: Secure countertops to cabinets with Z-type fasteners or equivalent, using two or more fasteners at each cabinet front, end, and back.
- E. Provide chemical-resistant, permanently elastic sealing compound for closures at junctures of top, curb, and splash, with walls as recommended by manufacturer for materials involved.

3.04 CLEANING AND PROTECTING

- A. Clean finished surfaces, touch up as required, and remove or refinish damaged or soiled areas to match original factory finish, as approved by Architect.
- B. Protect countertop surfaces during construction with 6-mil plastic or other suitable water-resistant covering. Tape to underside of countertop at minimum of 48 inches o.c.

END OF SECTION 12 36 16

SECTION 12 48 16**ENTRANCE FLOOR GRILLES****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. This Section includes recessed foot grilles and frames.
- B. Related Sections include the following:
 - 1. Division 03 Section "Cast-in-Place Concrete" for slab depression grouting and filling for recessed foot grilles and frames.

1.03 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Provide foot grilles and frames capable of withstanding the following loads and stresses:
 - 1. Uniform floor load min 300 lbf/sq. ft..
 - 2. Wheel load min 400 lb per wheel.

1.04 SUBMITTALS

- A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for foot grilles and frames.
- B. Shop Drawings: Show the following:
 - 1. Divisions between grille sections.
 - 2. Perimeter floor moldings.
- C. Samples for Verification: For each type of product indicated.
 - 1. Foot Grille: 12-inch- square assembled sections.
 - 2. Frame Members: 12-inch- long Sample of each type and color.
- D. Maintenance Data: For foot grilles and frames to include in maintenance manuals.

1.05 QUALITY ASSURANCE

- A. Source Limitations: Obtain foot grilles and frames through one source from a single manufacturer.
- B. Accessibility Requirements: Provide installed foot grilles that comply with Section 4.5 in the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA), Accessibility Guidelines for Buildings and Facilities (ADAAG)."

1.06 PROJECT CONDITIONS

- A. Field Measurements: Indicate measurements on Shop Drawings.

1.07 COORDINATION

- A. Coordinate size and location of recesses in concrete to receive foot grilles and frames where applicable.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide the products indicated below or a comparable product by one of the following:
 1. ARDEN Architectural Specialties, Inc.
 2. Balco, Inc.
 3. Pawling Corporation; Architectural Products Division.

2.02 MATERIALS

- A. Aluminum Sheet: ASTM B 209, alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with not less than strength and durability properties of Alloy 5005-H15.
- B. Extruded Aluminum: ASTM B 221, Alloy 6061-T6 or Alloy 6063-T5, T6, or T52 as standard with manufacturer. Coat surface of frame in contact with cementitious materials with manufacturer's standard protective coating.

2.03 FOOT GRILLES

- A. General: Provide manufacturer's standard foot-grille assemblies consisting of treads of type and profile indicated, interlocked or joined together by cross members, and with support legs (if any) and other components needed to produce a complete installation.
- B. Aluminum Foot Grilles Foot Grille:
 1. Basis of Design: Provide Pedimat M1 by C/S Group, with extruded members, with carpet insert treads, and as follows:
 - a. Tread Rails: Extruded-aluminum tread rails with extruded-aluminum frame.
 - b. Tread Rail Spacing: 1-1/2 inches o.c. with 1/8- to 3/16-inch wide openings between treads.
 - 1) Aluminum Finish: Anodized
 - c. Top Surface: Carpet insert.
 - 1) Refer to Drawings for carpet style and color
 - d. Grille Size: As indicated on Drawings.
- C. Lockdown: Hidden.

2.04 FRAMES

- A. Provide manufacturer's standard frames of size and style for grille type, for permanent recessed installation in subfloor, complete with installation anchorages and accessories. Unless otherwise indicated, fabricate frame of same material and finish as grilles.

2.05 SUPPORT SYSTEM

- A. Level Bed Applications: Provide manufacturer's standard, vinyl cushion support system.

2.06 FABRICATION

- A. Shop fabricate foot grilles to greatest extent possible in sizes as indicated. Unless otherwise indicated, provide each grille as a single unit; do not exceed manufacturer's recommended maximum sizes for units that are removed for maintenance and cleaning. Where joints in grilles are necessary, space symmetrically and away from normal traffic lanes.
- B. Fabricate frame members in single lengths or, where frame dimensions exceed maximum available lengths, provide minimum number of pieces possible, with hairline joints equally spaced and pieces spliced together by straight connecting pins.

2.07 FINISHES, GENERAL

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

2.08 ALUMINUM FINISHES

- A. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
- B. Class I, Clear Anodic Finish: AA-M12C22A41 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates and floor conditions for compliance with requirements for location, size, minimum recess depth, and other conditions affecting installation of foot grilles and frames.
- B. Examine roughing-in for drainage piping systems to verify actual locations of piping connections before foot grille and frame and drain pan installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install recessed foot grilles and frames to comply with manufacturer's written instructions at locations indicated and with top of foot grilles and frames in

relationship to one another and to adjoining finished flooring as recommended by manufacturer. Set foot-grille tops at height for most effective cleaning action. Coordinate top of foot-grille surfaces with doors that swing across grilles to provide clearance under door.

3.03 PROTECTION

- A. After completing frame installations, provide temporary filler of plywood or fiberboard in foot-grille recesses and cover frames with plywood protective flooring. Maintain protection until construction traffic has ended and Project is near Substantial Completion.

END OF SECTION 12 48 16

SECTION 12 93 00**SITE FURNISHINGS****PART 1 - GENERAL****1.1. RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2. SUMMARY

- A. This Section includes the following:
1. Seating.
 2. Bicycle Racks.
 3. Trash Receptacles.
- B. Related Sections include the following:
1. Division 03 Section "Cast-in-Place Concrete" for installation of anchor bolts in concrete footings.
 2. Division 31 Section "Earth Moving" for excavation for installation of concrete footings.

1.3. SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. LEED Submittals:
1. Product Data for Credit MR 4.1 and Credit MR 4.2: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
 - a. Include statement indicating costs for each product having recycled content.
 2. Product Data for Credits MR 5.1 and 5.2 - Local/Regional Materials:
 - a. Indicate location of manufacturing facility, including name, address, and distance between manufacturing facility and the project site. Provide manufacturer's documentation indicating location where the base materials were extracted, mined, quarried, harvested, etc. and the distance between this location and the project site. Also include material costs, excluding cost of installation.
- C. Samples for Initial Selection: For units with factory-applied color finishes.
- D. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below.
1. Size: Not less than 6-inch- long linear components and 4-inch- square sheet components.
 2. Full Size: Bench.

- E. Product Schedule: For site furnishings. Use same designations indicated on Drawings.
- F. Maintenance Data: For site furnishings to include in maintenance manuals.

1.4. QUALITY ASSURANCE

- A. Source Limitations: Obtain each type of site furnishing(s) through one source from a single manufacturer.

PART 2 - PRODUCTS

2.1. MATERIALS

- A. Recycled Content of Steel and Aluminum Products: Provide products with an average recycled content of steel or aluminum products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent..
- B. Anchors, Fasteners, Fittings, and Hardware: Manufacturer's standard, corrosion-resistant-coated or noncorrodible materials; commercial quality, tamperproof, vandal and theft resistant, concealed, recessed, and capped or plugged.
 - 1. Angle Anchors: For inconspicuously bolting legs of site furnishings to below-grade substrate; extent as indicated.
- C. Nonshrink, Nonmetallic Grout: Premixed, factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107; recommended in writing by manufacturer, for exterior applications.
- D. Erosion-Resistant Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with potable water at Project site to create pourable anchoring, patching, and grouting compound; resistant to erosion from water exposure without needing protection by a sealer or waterproof coating; recommended in writing by manufacturer, for exterior applications.

2.2. SEATING

- A. Basis-of-Design Product: Subject to compliance with requirements, provide:
 - 1. Landscape Forms
 - a. Model: Melville Bench.
 - b. Style: Backless.
 - c. Mounting: Surface mount.
 - d. Option: No dividers.
 - e. Seat panel material: Aluminum.
 - f. Color: Olive.

2.3. TRASH RECEPTACLES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide:
 - 1. Landscape Forms
 - a. Model: Poe.
 - b. Style: Side-opening.
 - c. Mounting: Surface mount.
 - d. Option: Lock.
 - e. Color: Olive.

2.4. BICYCLE RACKS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide:
 - 1. Landscape Forms
 - a. Model: Key.
 - b. Mounting: Embedded.
 - c. Color: Red.

2.5. FINISHES, GENERAL

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.6. ALUMINUM FINISHES

- A. Baked-Enamel, Powder-Coat Finish: Manufacturer's standard, baked, polyester, powder-coat finish complying with finish manufacturer's written instructions for surface preparation, including pretreatment, application, baking, and minimum dry film thickness.

PART 3 - EXECUTION**3.1. EXAMINATION**

- A. Examine areas and conditions, with Installer present, for compliance with requirements for correct and level finished grade, mounting surfaces, installation tolerances, and other conditions affecting performance.
 - 1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2. INSTALLATION, GENERAL

- A. Comply with manufacturer's written installation instructions unless more stringent requirements are indicated. Complete field assembly of site furnishings where required.
- B. Unless otherwise indicated, install site furnishings after landscaping and paving have been completed.
- C. Install site furnishings level, plumb, true, and securely anchored and positioned at locations indicated on Drawings.

3.3. CLEANING

- A. After completing site furnishing installation, inspect components. Remove spots, dirt, and debris. Repair damaged finishes to match original finish or replace component.

END OF SECTION

SECTION 12 93 00**BENCHES****PART 1 - GENERAL****1.1 SUMMARY**

- A. This Section includes custom benches to be provided at specific stations per drawings.

1.2 SUBMITTALS

- A. Product Data: Include sealed drawings by a structural engineer licensed in the State of Missouri, construction details, material descriptions, dimensions of individual components and profiles, finishes, actual tamper proof canopy anchors, field-assembly requirements, and installation details.
- a. Sealed drawings shall include calculations, description of members sizes, and connection details designed to withstand a 250lb per lineal foot (LF) load along the outside edge of the bench with a maximum deflection of ¼" per LF.

1.3 QUALITY ASSURANCE

- A. Provide a full scale mock-up of the bench for review and approval for the method assembly and finish treatments.

PART 2 - PRODUCTS**2.1 MANUFACTURERS**

- A. The contractor shall fabricate the custom bench as indicated in the drawings.

2.2 MATERIALS

- A. Seat and back panels:
Wood: Ipe with natural, smooth finish
- B. Frame:
1. Supports: Stainless steel, honed finish
- C. Anchor(s) shall be stainless steel and have tamperproof heads and shall be provided and installed by contractor per Contract Drawings.

PART 3 - EXECUTION**3.1 EXAMINATION**

- A. Examine areas and conditions, with Installer present, for compliance with requirements for correct and level finished grade, mounting surfaces, installation tolerances, and other conditions affecting performance.

3.2 INSTALLATION, GENERAL

- A. Contractor shall determine means of assembly and installation. Complete field assembly of benches, where required.
- B. Install benches level, plumb, true, and securely anchored at locations indicated on Drawings.

3.3 CLEANING

- A. After completing installation, inspect components. Remove spots, dirt, and debris from surrounding surfaces and finishes. Repair damaged finishes to match original finish or replace component.

PART 4 - MEASUREMENT

- 4.1 Measurement** – No Separate measurement will be made for Work described in this Section.

PART 5 - PAYMENT

- 5.1 Payment** – Payment for items in this Section will be incidental to the Contract lump sum cost of the Station Stops.

END OF SECTION

SECTION 12 93 43**PRECAST CONCRETE SITE BENCHES****PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes precast concrete seating blocks.
- B. Related Sections:
 - 1. Division 31 Section "Earth Moving" for excavation and compacted subgrade.

1.3 ACTION SUBMITTALS

- A. Product Data: For materials other than water.
 - 1. For precast concrete units, include construction details, material descriptions, dimensions of individual units and profiles, and finishes.
- B. LEED Submittals:
 - 1. Product Data for Credit MR 4.1 and Credit MR 4.2 – Recycled Content: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
 - a. Include statement indicating costs for each product having recycled content.
 - 2. Product Data for Credits MR 5.1 and 5.2 - Local/Regional Materials:
 - a. Indicate location of manufacturing facility, including name, address, and distance between manufacturing facility and the project site. Provide manufacturer's documentation indicating location where the base materials were extracted, mined, quarried, harvested, etc. and the distance between this location and the project site. Also include material costs, excluding cost of installation.
- C. Shop Drawings: Show fabrication and installation details for precast concrete units. Include dimensions, details of reinforcement and anchorages if any, and indication of finished faces.
 - 1. Include site plans showing layout of units and locations of joints and finished faces.
- D. Samples for Initial Selection: For concrete color and textured finish.
- E. Samples for Verification: For each color and texture required, 8 to 12 inches square.

- F. Full-Size Samples: One precast unit required.
 - 1. Make available for Architect's review at Project site.
 - 2. Approved Samples may be installed in the Work.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For manufacturer.
- B. Material Test Reports: For each mix required to produce precast concrete, based on testing according to ASTM C 1364, including test for resistance to freezing and thawing.
 - 1. Provide test reports based on testing within previous two years for products of similar size, thickness, and volume.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A qualified manufacturer of precast concrete units similar to those indicated for this Project, that has sufficient production capacity to manufacture required units, and is a plant certified by the Cast Stone Institute, the Architectural Precast Association, or the Precast/Prestressed Concrete Institute for Group A, Category AT.
- B. Source Limitations for Precast Concrete: Obtain precast concrete units through single source from single manufacturer.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Coordinate delivery of precast concrete to avoid delaying the Work and to minimize the need for on-site storage.
- B. Pack, handle, and ship precast concrete units in suitable packs or pallets.
 - 1. Lift with wide-belt slings; do not use wire rope or ropes that might cause staining. Move precast concrete units, if required, using dollies with wood supports or provide protection in the form of padding to facilitate skid lifting through recessed grooves provided in cast unit.
 - 2. Store precast concrete units on wood skids or pallets with nonstaining, waterproof covers, securely tied. Arrange to distribute weight evenly and to prevent damage to units.

PART 2 - PRODUCTS

2.1 PRECAST CONCRETE MATERIALS

- A. General: Comply with ASTM C 1364 and the following:
- B. Portland Cement: ASTM C 150, Type I or Type III, containing not more than 0.60 percent total alkali when tested according to ASTM C 114.
- C. Coarse Aggregates: Recycled concrete complying with ASTM C 33; gradation and colors as needed to produce required precast concrete textures and colors.
- D. Fine Aggregates: Natural sand or crushed stone complying with ASTM C 33, gradation and colors as needed to produce required precast concrete textures and colors.
- E. Exposed Seeded Aggregate:

1. Aggregate Size: 3/8 inch nominal.
 2. Product: Charcoal angular granite.
- F. Color Pigment: ASTM C 979, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable, nonfading, and resistant to lime and other alkalis.
- G. Admixtures: Use only admixtures specified or approved in writing by Architect.
1. Do not use admixtures that contain more than 0.1 percent water-soluble chloride ions by mass of cementitious materials. Do not use admixtures containing calcium chloride.
 2. Use only admixtures that are certified by manufacturer to be compatible with cement and other admixtures used.
 3. Air-Entraining Admixture: ASTM C 260. Add to mixes for units exposed to the exterior at manufacturer's prescribed rate to result in an air content of 4 to 6 percent, except do not add to zero-slump concrete mixes.
 4. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
 5. Water-Reducing, Retarding Admixture: ASTM C 494/C 494M, Type D.
 6. Water-Reducing, Accelerating Admixture: ASTM C 494/C 494M, Type E.
- H. Reinforcement: Deformed steel bars complying with ASTM A 615/A 615M, Grade 60. Use galvanized or epoxy-coated reinforcement when covered with less than 1-1/2 inches of precast concrete material.
1. Epoxy Coating: ASTM A 775/A 775M.
 2. Galvanized Coating: ASTM A 767/A 767M.

2.2 PRECAST CONCRETE UNITS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. xxxxxxxx.
- B. Regional Materials: Precast concrete units shall be manufactured within 500 miles of Project site from aggregates that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles of Project site.
- C. Provide precast concrete units complying with ASTM C 1364 using either the vibrant dry tamp or wet-cast method.
1. Provide units that are resistant to freezing and thawing as determined by laboratory testing according to ASTM C 666/C 666M, Procedure A, as modified by ASTM C 1364.
- D. Fabrication Tolerances:
1. Variation in Cross Section: Do not vary from indicated dimensions by more than 1/8 inch.
 2. Variation in Length: Do not vary from indicated dimensions by more than 1/360 of the length of unit or 1/8 inch, whichever is greater, but in no case by more than 1/4 inch.
 3. Warp, Bow, and Twist: Not to exceed 1/360 of the length of unit or 1/8 inch, whichever is greater.
 4. Location of Grooves, False Joints, Holes, and Similar Features: Do not vary from indicated position by more than 1/8 inch on formed surfaces of units and 3/8 inch on unformed surfaces.

- E. Cure units as follows:
1. Cure units in enclosed moist curing room at 95 to 100 percent relative humidity and temperature of 100 deg F for 12 hours or 70 deg F for 16 hours.
 2. Keep units damp and continue curing to comply with one of the following:
 - a. No fewer than five days at mean daily temperature of 70 deg F or above.
 - b. No fewer than six days at mean daily temperature of 60 deg F or above.
 - c. No fewer than seven days at mean daily temperature of 50 deg F or above.
 - d. No fewer than eight days at mean daily temperature of 45 deg F or above.
- F. Acid etch units after curing to remove cement film from surfaces to be exposed to view.
- G. Polish and grind one long vertical face to reveal seeded aggregates. Finish shall be consistent, smooth, and created glossy appearance differentiating face from remaining non-polished faces.
- H. Concrete Mixture/Finish: Match initial sample provided by Architect to Precast Manufacturer, use following as reference only:
1. Ingredients per cubic yard:
 - a. Color – DCS #2703 Black 2.72#
 - b. Cement – White – 680#
 - c. Aggregate – Canyon Grey 1 – 1700#
 - d. Sand – Light Gray Sand – 12500#

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION TOLERANCES

- A. Variation from Plumb: Do not exceed 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.
- B. Variation from Level: Do not exceed 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.
- C. Variation in Plane between Adjacent Surfaces (Lipping): Do not vary from flush alignment with adjacent units or adjacent surfaces indicated to be flush with units by more than 1/8 inch, except where variation is due to warpage of units within tolerances specified.

3.3 ADJUSTING AND CLEANING

- A. Remove and replace stained and otherwise damaged units and units not matching approved Samples. Precast concrete may be repaired if methods and results are approved by Architect.

- B. Replace units in a manner that results in precast concrete matching approved Samples, complying with other requirements, and showing no evidence of replacement.
- C. Construction Waste Management And Disposal: Comply with Waste Management Plan required under Division 01 Section "Construction Waste Management And Disposal."

END OF SECTION

SECTION 13 13 50
STATION PLATFORMS**PART I - GENERAL****1.1 SUMMARY**

- A. Description
1. Work of this Section includes, but is not limited to construction of all elements of the station platforms.
- B. Related Sections
1. Section 03 11 10 – Concrete Formwork
 2. Section 03 15 10 – Concrete Flatwork
 3. Section 03 20 10 – Concrete Reinforcement
 4. Section 03 25 10 – Concrete Joint Control
 5. Section 03 31 05 – Structural Concrete
 6. Section 03 35 10 – Concrete Finishing
 7. Section 03 39 00 – Concrete Curing
 8. Section 05 05 05 – Galvanic Corrosion Protection
 9. Section 05 12 00 – Structural Steel Framing
 10. Section 05 12 13 – Architecturally Exposed Structural Steel
 11. Section 05 50 00 – Metal Fabrications
 12. Section 05 50 13 – Steel Railings
 13. Section 05 58 00 – Sheet Metal Panels
 14. Section 05 73 13 – Glass Railings
 15. Section 07 92 13 – Exterior Joint Sealants
 16. Section 08 81 00 – Glass and Glazing
 17. Section 08 84 00 – Plastic Glazing
 18. Section 09 61 13 – Cast in Place Tactile Warning Surface Tiles
 19. Section 09 91 13.10 – Exterior Painting
 20. Section 12 93 10 – Benches
 21. Section 26 05 19 – Low-Voltage Electrical Power
 22. Section 26 05 26 – Grounding and Bonding for Electrical Systems
 23. Section 26 05 33 – Raceways and Boxes for Electrical Systems
 24. Section 26 05 43 – Underground Ducts
 25. Section 26 05 53 – Identification for Electrical Systems
 26. Section 26 27 26 – Wiring Devices
 27. Section 26 28 16 – Enclosed Switches and Circuit Breakers
 28. Section 26 56 10 – Station Stop Lighting
 29. Section 31 23 16.16 – Structural Excavation and Backfill
 30. Section 32 11 00 – Aggregate Base Course

1.2 SUBMITTALS AND INFORMATION TO BE RETAINED

- A. Submittals shall be made in accordance with the requirements of the Project Quality Plan, except as modified herein.
- B. As indicated in the Related Sections listed in this Section, Paragraph 1.1.B.

1.3 QUALITY ASSURANCE/QUALITY CONTROL

- A. Quality assurance/quality control shall be in accordance with the Quality Plan and the General Provisions, except as modified herein.
- B. As indicated in the Related Sections listed in this Section, Paragraph 1.1.B
- C. To minimize construction problems, wherever possible, the Contractor shall complete work of an initial platform item of work before beginning fabrication and work on the remaining platform items; i.e., structural framing, canopy sheet metal panels, railings, foundations, irrigation sprinkling, lighting, heat tracing, etc.

1.4 DELIVERY, STORAGE AND HANDLING

As indicated in the Related Sections listed in this Section, Paragraph 1.1.B.

PART II - PRODUCTS**2.1 MATERIALS**

As indicated in the Design Drawings and/or Related Sections listed in this Section, Paragraph 1.1.B.

2.2 FABRICATION

As indicated in the Design Drawings and/or Related Sections listed in this Section, Paragraphs 1.1.B.

PART III - EXECUTION**3.1 PREPARATION**

As indicated in the Design Drawings and/or Related Sections listed in this Section, Paragraph 1.1.B.

3.2 INSTALLATION

As indicated in the Design Drawings and/or Related Sections listed in this Section, Paragraph 1.1.B.

3.3 FIELD QUALITY CONTROL

As indicated in the Related Sections listed in this Section, Paragraph 1.1.B.

3.4 ADJUSTING AND CLEANING

As indicated in the Related Sections listed in this Section, Paragraph 1.1.B.

3.5 PROTECTION

As indicated in the Related Sections listed in this Section, Paragraph 1.1.B.

PART 4 - MEASUREMENT

- 4.1 Measurement** – No Separate measurement will be made for Work described in this Section.

PART 5 - PAYMENT

5.1 Payment – Payment for items in this Section will be a lump sum cost for each Station Stop location.

END OF SECTION

SECTION 14 21 44**MACHINE ROOM-LESS ELECTRIC TRACTION ELEVATORS**

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. This Section includes machine room-less (MRL) electric traction service elevators.
- B. Related Sections include the following:
 - 1. Division 03 Section "Cast-in-Place Concrete" for setting sleeves, inserts, and anchoring devices in concrete.
 - 2. Division 04 Section "Unit Masonry Assemblies" for setting sleeves, inserts, and anchoring devices in masonry and for grouting elevator entrance frames installed in masonry walls.
 - 3. Division 05 Section "Structural Steel" for the following:
 - a. Attachment plates, angle brackets, and other preparation of structural steel for fastening guide-rail brackets.
 - b. Hoist beams.
 - c. Structural-steel shapes for subsills that are part of steel frame.
 - 4. Division 05 Section "Metal Fabrications" for the following:
 - a. Attachment plates and angle brackets for supporting guide-rail brackets.
 - b. Divider beams.
 - c. Hoist beams.
 - d. Structural-steel shapes for subsills.
 - e. Pit ladders.
 - f. Cants in hoistways made from steel sheet.
 - 5. Division 09 painting Sections for field painting of hoistway entrance doors and frames.
 - 6. Division 26 Sections for electrical service for elevators to and including fused disconnect switches at control room door and standby power source, transfer switch, and connection from auxiliary contacts in transfer switch to controller.
 - 7. Division 27 Section "Communications Horizontal Cabling" for telephone service for elevators.
 - 8. Division 28 Section "Access Control" for security access system equipment used to restrict elevator use.
 - 9. Division 28 Section "Fire Detection and Alarm" for smoke detectors in elevator lobbies to initiate emergency recall operation and heat detectors in shafts and control rooms to disconnect power from elevator equipment before sprinkler activation and for connection to elevator controllers.

1.03 DEFINITIONS

- A. Definitions in ASME A17.1 apply to work of this Section.
- B. Defective Elevator Work: Operation or control system failure, including excessive

malfunctions; performances below specified ratings; excessive wear; unusual deterioration or aging of materials or finishes; unsafe conditions; need for excessive maintenance; abnormal noise or vibration; and similar unusual, unexpected, and unsatisfactory conditions.

- C. Service Elevator: A passenger elevator that is also used to carry freight.

1.04 SUBMITTALS

- A. Product Data: Include capacities, sizes, performances, operations, safety features, finishes, and similar information. Include product data for the following:
1. Car enclosures and hoistway entrances.
 2. Operation, control, and signal systems.
- B. Shop Drawings: Show plans, elevations, sections, and large-scale details indicating service at each landing, control room layout, coordination with building structure, relationships with other construction, and locations of equipment and signals. Include large-scale layout of car control station and standby power operation control panel. Indicate variations from specified requirements, maximum dynamic and static loads imposed on building structure at points of support, and maximum and average power demands.
- C. Samples for Initial Selection: For finishes involving color selection.
- D. Samples for Verification: For exposed finishes of cars, hoistway doors and frames, and signal equipment; 3-inch-square Samples of sheet materials; and 4-inch lengths of running trim members.
- E. Manufacturer Certificates: Signed by elevator manufacturer certifying that hoistway, pit, and control room layout and dimensions, as shown on Drawings, and electrical service, as shown and specified, are adequate for elevator system being provided.
- F. Qualification Data: For Installer.
- G. Operation and Maintenance Data: For elevators to include in emergency, operation, and maintenance manuals.
1. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include diagnostic and repair information available to manufacturer's and Installer's maintenance personnel.
- H. Inspection and Acceptance Certificates and Operating Permits: As required by authorities having jurisdiction for normal, unrestricted elevator use.
- I. Warranty: Special warranty specified in this Section.
- J. Continuing Maintenance Proposal: Service agreement specified in this Section.

1.05 QUALITY ASSURANCE

- A. Installer Qualifications: Elevator manufacturer or manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
- B. Source Limitations: Obtain elevators, including machine room-less electric traction passenger elevators specified in another Division 14 Section, through one source from a single manufacturer.

1. Provide major elevator components, including driving machines, controllers, signal fixtures, door operators, car frames, cabs, and entrances, manufactured by a single manufacturer.
- C. Regulatory Requirements: Comply with ASME A17.1.
 1. Effective peak velocity acceleration (A_v) for Project's location is less than 0.10 (seismic risk zones 0 and 1)
 2. Elevator importance factor is 1.0.
- D. Accessibility Requirements: Comply with Section 407 in ICC A117.1.
- E. Fire-Rated Hoistway Entrance Assemblies: Door and frame assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing at as close to neutral pressure as possible according to NFPA 252.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle materials, components, and equipment in manufacturer's protective packaging.
- B. Store materials, components, and equipment off of ground, under cover, and in a dry location. Handle according to manufacturer's written recommendations to prevent damage, deterioration, or soiling.

1.07 COORDINATION

- A. Coordinate installation of sleeves, block outs, elevator equipment with integral anchors, and other items that are embedded in concrete or masonry for elevator equipment. Furnish templates, sleeves, elevator equipment with integral anchors, and installation instructions and deliver to Project site in time for installation.
- B. Coordinate sequence of elevator installation with other work to avoid delaying the Work.
- C. Coordinate locations and dimensions of other work relating to electric traction elevators including pit ladders, sumps, and floor drains in pits; entrance subsills; and electrical service, electrical outlets, lights, and switches in pits.

1.08 WARRANTY

- A. Special Manufacturer's Warranty: Manufacturer's standard form in which manufacturer agrees to repair, restore, or replace defective elevator work within specified warranty period.
 1. Warranty Period: One year from date of Substantial Completion.

1.09 MAINTENANCE SERVICE

- A. Initial Maintenance Service: Beginning at Substantial Completion, provide one year's full maintenance service by skilled employees of elevator Installer. Include monthly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper elevator operation at rated speed and capacity. Provide parts and supplies same as those used in the manufacture and installation of original equipment.

1. Perform maintenance, including emergency callback service, during normal working hours.
2. Include 24-hour-per-day, 7-day-per-week emergency callback service.
 - a. Response Time: Two hours or less.
- B. Continuing Maintenance Proposal: Provide a continuing maintenance proposal from Installer to Owner with terms, conditions, and obligations as set forth in, and in same form as, "Draft of Elevator Maintenance Agreement" at end of this Section, starting on date initial maintenance service is concluded.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Basis of Design: Subject to requirements, provide EcoSpace Machine Room-less Elevator by KONE.

2.02 SYSTEMS AND COMPONENTS

- A. General: Provide manufacturer's standard elevator systems. Where components are not otherwise indicated, provide standard components published by manufacturer as included in standard preengineered elevator systems and as required for complete system.
- B. Elevator Machines: At manufacturer's option, provide either variable-voltage, variable-frequency, ac-type or variable-voltage, dc-type hoisting machines. Provide solid-state power converters.
- C. Fluid for Oil Buffers: If oil buffers are used, use only fire-resistant hydraulic fluid containing antioxidant, anticorrosive, antifoaming, and metal-passivating additives.
 1. Available Product: Subject to compliance with requirements, a product that may be incorporated into the Work includes, but is not limited to, "Hydro Safe (FR)" by Hydro Safe Oil Division, Inc.
- D. Inserts: Furnish required concrete and masonry inserts and similar anchorage devices for installing guide rails, machinery, and other components of elevator work where installation of devices is specified in another Section.
- E. Car Frame and Platform: Welded steel units.
- F. Guides: Provide roller guides at top and bottom of car and counterweight frames.

2.03 OPERATION SYSTEMS

- A. General: Provide manufacturer's standard microprocessor operation system as required to provide type of operation system indicated.
- B. Auxiliary Operations: In addition to primary operation system features, provide the following operational features for elevators where indicated:
 1. Standby Power Operation: On activation of standby power, car is returned to a designated floor and parked with doors open. Car can be manually put in service on standby power, either for return operation or for regular operation, by switches in control panel located at main lobby. Manual operation causes automatic operation to cease.

2. Battery-Powered Lowering: If power fails and car is at a floor, it remains at that floor, opens its doors, and shuts down. If car is between floors, it is lowered to the next floor below, opens its doors, and shuts down. System includes rechargeable battery and automatic recharging system.
 3. Automatic Dispatching of Loaded Car: When car load exceeds 80 percent of rated capacity, doors will begin closing.
 4. Nuisance Call Cancel: When car calls exceed a preset number while car load is less than a predetermined weight, all car calls are canceled. Preset number of calls can be adjusted.
- C. Security Features: Provide the following security features, where indicated. Security features shall not affect emergency firefighters' service.
1. Card-Reader Operation: System uses card readers at car control stations to authorize calls. Security system determines which landings and at what times calls require authorization by card reader. Provide required conductors in traveling cable and panel in control room for interconnecting card readers, other security access system equipment, and elevator controllers. Allow space as indicated for card reader in car.
 - a. Security access system equipment is specified in Division 28 Section "Access Control."
 - b. Security access system equipment is not in the Contract.
 2. Keyswitch Operation: Push buttons are activated and deactivated by security keyswitches at car control stations and hall push-button stations. Key is removable only in deactivated position.
 3. Keypad Operation: Allows each landing to be restricted or unrestricted. When a restricted landing button is pressed, a "Restricted Floor" lamp lights and remains lit until landing access code has been entered into a keypad or predetermined time period has elapsed. Car calls for restricted landings do not register until landing access code is entered into keypad within predetermined time period after landing button is pressed.
 - a. Access codes are programmed at each car operating panel using a security keyswitch. Keypad operation can be activated and deactivated by security keyswitch at main landing.
 4. Car-to-Lobby Feature: Feature, activated by keyswitch at main lobby, that causes car to return immediately to lobby and open doors for inspection. On deactivation by keyswitch, calls registered before keyswitch activation are completed and normal operation is resumed.

2.04 DOOR REOPENING DEVICES

- A. Infrared Array: Provide door reopening devices with uniform array of 36 or more microprocessor-controlled, infrared light beams projecting across car entrance. Interruption of one or more of the light beams shall cause doors to stop and reopen.
- B. Nudging Feature: After car doors are prevented from closing for predetermined adjustable time, through activating door reopening device, a loud buzzer shall sound and doors shall begin to close at reduced kinetic energy.

2.05 FINISH MATERIALS

- A. General: Provide the following materials for exposed parts of elevator car enclosures, car doors, hoistway entrance doors and frames, and signal equipment as indicated.

- B. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, commercial steel, Type B, exposed, matte finish.
- C. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, commercial steel, Type B, pickled.
- D. Stainless-Steel Sheet: ASTM A 240/A 240M, Type 304.
- E. Stainless-Steel Bars: ASTM A 276, Type 304.
- F. Stainless-Steel Tubing: ASTM A 554, Grade MT 304.
- G. Bronze Plate and Sheet: ASTM B 36/B 36M, Alloy UNS No. C28000 (muntz metal).
- H. Bronze Extrusions: ASTM B 455, Alloy UNS No. C38500 (architectural bronze).
- I. Bronze Tubing: ASTM B 135, Alloy UNS No. C23000 (red brass, 85 percent copper).
- J. Aluminum Extrusions: ASTM B 221, Alloy 6063.
- K. Nickel Silver Extrusions: ASTM B 151/B 151M, Alloy UNS No. C74500 or No. C77600.

2.06 CAR ENCLOSURES

- A. General: Provide enameled-steel car enclosures to receive removable wall panels, with car roof, access doors, power door operators, and ventilation.
 - 1. Provide standard railings complying with ASME A17.1 on car tops where required by ASME A17.1.
 - 2. Provide finished car including materials and finishes specified below.

2.07 HOISTWAY ENTRANCES

- A. General: Provide manufacturer's standard horizontal-sliding, door-and-frame hoistway entrances complete with track systems, hardware, sills, and accessories. Provide frame size and profile to coordinate with hoistway wall construction.
 - 1. Where gypsum board wall construction is indicated, provide self-supporting frames with reinforced head sections.
- B. Materials and Fabrication: Provide manufacturer's standards, but not less than the following:
 - 1. Enameled-Steel Frames: Formed from cold-rolled or hot-rolled steel sheet. Provide with factory-applied enamel finish; colors as selected by Architect from manufacturer's full range.
 - 2. Steel Subframes: Formed from cold-rolled or hot-rolled steel sheet with factory-applied enamel finish or corrosion-inhibiting primer. Fabricate to receive applied finish as indicated.
 - 3. Stainless-Steel Frames: Formed from stainless-steel sheet.
 - 4. Stainless-Steel Doors: Flush, hollow-metal construction; fabricated from stainless-steel sheet or by laminating stainless-steel sheet to exposed faces and edges of enameled cold-rolled steel doors using adhesive that fully bonds metal to metal without telegraphing or oil-canning.
 - 5. Sight Guards: Provide sight guards on doors matching door edges.
 - 6. Sills: Extruded metal, with grooved surface, 1/4 inch thick.
 - 7. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107.

2.08 SIGNAL EQUIPMENT

- A. General: Provide Kone KSS 370 signalization.
- B. Emergency Communication System: Provide system that complies with ASME A17.1 and the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA), Accessibility Guidelines for Buildings and Facilities (ADAAG)." On activation, system dials preprogrammed number of monitoring station and identifies elevator location to monitoring station. System provides two-way voice communication without using a handset and provides visible signals that indicate when system has been activated and when monitoring station has responded. System is contained in flush-mounted cabinet, with identification, instructions for use, and battery backup power supply.
- C. Firefighters' Two-Way Telephone Communication Service: Provide flush-mounted cabinet in each car and required conductors in traveling cable for firefighters' two-way telephone communication service specified in Division 28 Section "Fire Detection and Alarm."

2.09 ELEVATORS

- A. Elevator Description:
 - 1. Elevator No. 1
 - 2. Type: Gearless traction.
 - 3. Machine Location: Hoistway; no machine room is provided.
 - 4. Rated Load: 2500 lb.
 - 5. Rated Speed: 150 fpm.
 - 6. Operation System: Selective collective automatic operation.
 - 7. Auxiliary Operations:
 - a. Standby power operation.
 - b. Battery-powered lowering.
 - c. Earthquake Emergency Operation: Comply with requirements in ASME A17.1.
 - d. Nuisance call cancel.
 - 8. Security Features: Keyswitch operation.
 - 9. Dual Car Control Stations: Provide two car control stations; equip only one with required keyswitches if any.
 - 10. Car Enclosures:
 - a. Inside Width: 80 inches from side wall to side wall.
 - b. Inside Depth: 60 inches from back wall to front wall (return panels).
 - c. Inside Height: 88 inches to underside of ceiling.
 - d. Front Walls (Return Panels): Satin stainless steel, No. 4 finish.
 - e. Car Fixtures: Satin stainless steel, No. 4 finish.
 - f. Side and Rear Wall Panels: Metal finish, 6312 Mercury Stria.
 - g. Reveals: Polished stainless steel, No. 8 finish.
 - h. Door Faces (Interior): Satin stainless steel, No. 4 finish.
 - i. Door Sills: Nickel silver, polished.
 - j. Ceiling: Type LF 94.
 - k. Handrails: 3 inch flat stainless steel bar.
 - l. Floor : Refer to Section 09 65 19 "Rubber Tile Flooring."
 - 11. Hoistway Entrances: As follows:

- a. Width: 48 inches.
- b. Height: 96 inches.
- c. Type: Two-speed side sliding.
- d. Frames: Satin stainless steel, No. 4 finish.
- e. Doors: Satin stainless steel, No. 4 finish.
- f. Sills: Aluminum, mill finish.
- g. Hall Fixtures: Satin stainless steel, No. 4 finish.
- h. Type: Single-speed side sliding.
- i. Fire-Protection Rating: 1 hour.
- j. Frames Satin stainless steel, No. 4 finish.
- k. Doors Satin stainless steel, No. 4 finish.
- l. Sills: Nickel silver, polished.

12. Additional Requirements:

- a. Provide inspection certificate in each car, mounted under acrylic cover with frame made from satin stainless steel, No. 4 finish.
- b. Provide blanket hooks and one complete set(s) of full-height protective blankets.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine elevator areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance. Examine hoistways, hoistway openings, pits, and control rooms as constructed; verify critical dimensions; and examine supporting structure and other conditions under which elevator work is to be installed.
 1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Comply with manufacturer's written instructions.
- B. Welded Construction: Provide welded connections for installing elevator work where bolted connections are not required for subsequent removal or for normal operation, adjustment, inspection, maintenance, and replacement of worn parts. Comply with AWS standards for workmanship and for qualifications of welding operators.
- C. Sound Isolation: Mount rotating and vibrating equipment on vibration-isolating mounts designed to minimize transmission of vibrations to structure and thereby minimize structure-borne noise from elevator system.
- D. Lubricate operating parts of systems, including ropes, as recommended by manufacturers.
- E. Alignment: Coordinate installation of hoistway entrances with installation of elevator guide rails for accurate alignment of entrances with car. Where possible, delay final adjustment of sills and doors until car is operable in shaft. Reduce clearances to minimum, safe, workable dimension at each landing.
- F. Leveling Tolerance: 1/8 inch, up or down, regardless of load and direction of travel.
- G. Set sills flush with finished floor surface at landing. Fill space under sill solidly with

nonshrink, nonmetallic grout.

H. Locate hall signal equipment for elevators as follows, unless otherwise indicated:

1. Place hall lanterns either above or beside each hoistway entrance.
2. Mount hall lanterns at a minimum of 72 inches above finished floor.

3.03 FIELD QUALITY CONTROL

- A. Acceptance Testing: On completion of elevator installation and before permitting use (either temporary or permanent) of elevators, perform acceptance tests as required and recommended by ASME A17.1 and by governing regulations and agencies.
- B. Operating Test: Load elevator to rated capacity and operate continuously for 30 minutes over full travel distance, stopping at each level and proceeding immediately to the next. Record temperature rise of elevator machine during 30-minute test period. Record failure to perform as required.
- C. Advise Owner, Architect, and authorities having jurisdiction in advance of dates and times tests are to be performed on elevators.

3.04 PROTECTION

- A. Temporary Use: Limit temporary use for construction purposes to one elevator. Comply with the following requirements for each elevator used for construction purposes:
 1. Provide car with temporary enclosure, either within finished car or in place of finished car, to protect finishes from damage.
 2. Provide strippable protective film on entrance and car doors and frames.
 3. Provide padded wood bumpers on entrance door frames covering jambs and frame faces.
 4. Provide other protective coverings, barriers, devices, signs, and procedures as needed to protect elevator and elevator equipment.
 5. Do not load elevators beyond their rated weight capacity.
 6. Engage elevator Installer to provide full maintenance service. Include preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as necessary for proper elevator operation at rated speed and capacity. Provide parts and supplies same as those used in the manufacture and installation of original equipment.
 7. Engage elevator Installer to restore damaged work, if any, so no evidence remains of correction. Return items that cannot be refinished in the field to the shop, make required repairs and refinish entire unit, or provide new units as required.

3.05 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to operate, adjust, and maintain elevator(s). Refer to Division 01 Section "Demonstration and Training."
- B. Check operation of elevator with Owner's personnel present and before date of Substantial Completion. Determine that operation systems and devices are functioning properly.

- C. Check operation of elevator with Owner's personnel present not more than one month before end of warranty period. Determine that operation systems and devices are functioning properly.

END OF SECTION 14 21 44

SECTION 14 45 00**VEHICLE LIFTS****PART 1 - GENERAL**

The General Provisions of the Contract, including General and Special Conditions and the requirements of Division 1, apply to the Work in this Section.

1.01 WORK INCLUDED

- A. Equipment items as listed below by Equipment Identifier:
 - 1. 5432 Lift, parts, 3,000 pounds (Ref. Part 2.01)
 - 2. 5876 Lift, portable, electric (set of 8) (Ref. Part 2.02)
 - 3. 5881 Lift, table, bogie (Ref. Part 2.03)
 - 4. 5950 Turntable, truck assembly (Ref. Part 2.04)
- B. Roughing-in, installation of equipment, and final connection of utilities, with labor, services, and incidentals necessary for complete and operational equipment installation.
- C. Piping, wiring, and switching between equipment and utilities.

1.02 QUALITY ASSURANCE

- A. Experience: Equipment shall be produced by a manufacturer of established reputation with a minimum of five years experience supplying specified equipment.
- B. Quality standards shall meet or exceed ISO-9001 and be certified by the Automotive Lift Institute (ALI).
- C. Manufacturer's Representative:
 - 1. Installation: Provide a qualified manufacturer's representative at site to supervise work related to equipment installation, check out, and start up.
 - 2. Training: Provide technical representative to provide training to Owner's maintenance personnel in operation and maintenance of specified equipment.
 - 3. Quality standards shall meet or exceed ISO-9001.

1.03 SUBMITTALS

- A. Product Data: Submit Product Data in accordance with Division 1 of these specifications.
- B. Operations and Maintenance Manual:

1. Submit Operations and Maintenance Manuals in accordance with Division 1- General Requirements of these specifications.
 2. Provide complete parts, operating, and maintenance manual covering equipment at time of installation.
 3. Description of system and components.
 4. Schematic diagrams of electrical, plumbing, and compressed air system.
 5. Manufacturer's printed operating instructions.
 6. Printed listing of periodic preventive maintenance items and recommended frequency to validate warranties. Failure to provide maintenance information will indicate that preventive maintenance is not a condition for validation of warranties.
- C. Shop Drawings:
1. Submit Shop Drawings in accordance with Division 1 - General Requirements.
 2. Submit site specific installation drawings and procedures.

1.04 PRODUCT SUBSTITUTIONS

- A. Follow requirements specified in Division 1 - General Requirements.
- B. Additional costs resulting from substitution of products other than those specified, by model number, including drawing changes and construction, will be at the expense of the Contractor.
- C. Substitution Approval: Prior to delivery or installation, submittals for each equipment item by Equipment Identifier shall be provided in accordance with Division 1 - General Requirements. Acceptance will be based on the technical requirements herein as determined by Owner and Architect.

1.05 WARRANTY

- A. Warrant work specified herein for one year from substantial completion against defects in materials, functions, and workmanship.
- B. Warranty shall include materials and labor necessary to correct defects.
- C. Defects shall include, but not be limited to noisy, rough or substandard operation; loose, damaged, and missing parts; and abnormal deterioration of finish. Defects shall not include damage due to neglect, misuse, or situations resulting from non-performance of a manufacturer's recommended preventive maintenance schedule.
- D. Submit warranties in accordance with Division 1 - General Requirements of these specifications.
- E. All parts shall be readily available locally in the United States.

1.06 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver equipment in manufacturer's containers, appropriately packaged and/or crated for protection during domestic shipment and storage in humid and/or dusty conditions.
- B. Indelibly label all containers, including those contained in others, on outside with item description(s) per title and Equipment Identifier of this specification.

1.07 LABELING

- A. Manufacturer shall securely attach in a prominent location, on each major item of equipment, a non-corrosive nameplate showing manufacturer's name, address, model number, serial number, and pertinent utility or operating data.
- B. Manufacturer shall securely attach the ALI label of the Automotive Lift Institute.
- C. All electrical equipment and materials shall be new and shall be listed by Underwriter's Laboratories, Inc. (UL) in categories for which standards have been set by that agency and labeled as such in the manufacturer's plant.

1.08 BUY AMERICA COMPLIANCE

- A. The Contractor shall comply with the applicable Buy America requirements set forth in 49 U.S.C. 5323(j) and the applicable regulations in 49 C.F.R. Part 661, as amended. If the Contractor procures any capital items with Federal funds, it is the Contractor's responsibility to obtain the Buy America certification required under such regulations.
- B. Reference Division 1 for Buy America provisions.

PART 2 - PRODUCTS

2.01 LIFT, PARTS, 3,000 POUNDS Equipment identifier: 5432

- A. Manufacturer's Reference:
 - 1. Prime manufacturer: Specifications are based on equipment identified herein by manufacturer's name and model to establish minimal acceptable standards of quality, features, performance, and construction.
 - a. Pflow Industries, Inc., Milwaukee, WI, 53209, (414) 352-9000
 - b. Model: Series M VRC
 - 2. Alternate manufacturers: Contingent upon compliance with these specifications and documentation requirements set forth in SUBMITTALS, equipment produced by other manufacturers, including the following, may be considered as equal.
- B. Capacity/Dimensions:
 - 1. Capacity: The vertical reciprocating lift shall be rated at a live load capacity of 3,000 pounds.

2. Operating levels: Four
3. Operating configuration: Cantilever
4. Speed: The vertical reciprocating lift shall have a lifting speed of 25 to 30 feet per minute when loaded to capacity.
5. Vertical travel: 14 feet 6 inches
6. Lift platform: The vertical reciprocating lift platform, also known as usable carriage, shall have steel deck plate and 48 inches high welded handrails and kick plates on non-operating ends and safety chains with snap hooks on operating ends.
7. Effective carriage length: 72 inches
8. Effective carriage width: 42 inches
9. Load height: 84 inches
10. Minimum high welded handrail height: 48 inches
11. Overall lift height (with 3 inch minimum clearance): 28 feet

C. Features/Performance/Construction:

1. Support columns: The vertical reciprocating lift shall have a minimum of two, 6-inch wide, roll formed support columns.
2. Deflection under load: When loaded to rated capacity, no portion of the vertical reciprocating lift shall exhibit permanent deformations.
3. Lifting means:
 - a. Raising and lowering of the carriage shall be provided a chain over sprocket with common drive shaft connected to an efficient helical gear reducer assembly. The lifting chain shall be in a guidance assembly.
4. Safety cams: Safety cams shall be mounted on the platform and connected directly to the lifting chains. The cams shall prevent the platform from falling more than 6 inches if tension is lost in the chains.
5. Signs: "NO RIDER" signs shall be provided. Lettering shall be a minimum of two inches high for visibility.

D. Electric motor:

1. Motor horsepower shall be sized for the rated live load specified speed.
2. All motors are three phase and shall be designed for continuous duty at ambient temperatures from 32 degrees to 102 degrees Fahrenheit.
3. The motor shall not automatically restart when the overload device is reset.
4. The motor shall be equipped with a heavy duty, fast-acting, fail safe industrial brake to ensure the brake will hold in case of power failure.

E. Controls:

1. Controls
 - a. Each operating floor level shall be equipped with a momentary contact push button control station with call, send, and mushroom style e-stop operators for manual control of lift operation.

- b. An internally pre-wired, National Electrical Manufacturers Association (NEMA) Type 12 rated main control panel shall be provided with step-down transfer reversing motor starter, overload relay, instantaneous current sensing jam relay, inrush bypass timer, field wiring terminal block, and positive acting brake contacts.
 - c. The VRC shall be equipped with a travel limit switch to control positioning of the VRC platform.
 - d. Chain tension safety device: Monitors each chain and shuts off motor while engaging brake in the event of a slack, taut, or broken chain.
- F. Utility Requirements:
- 1. Electrical: 460 VAC, 3 phase, 7.5 HP
 - a. All motors shall be designed for continuous duty at ambient temperatures from 32 degrees to 102 degrees F.
 - G. Finish: Paint with standard Pflow Blue industrial enamel. Prior to painting, all dirt, mill scale, oil, and grease shall be removed from carbon steel surfaces by a combination of brushing, wiping, and use of solvents.
- 2.02 LIFT, PORTABLE, ELECTRIC (set of 8)
Equipment Identifier: 5876
- A. Manufacturer's Reference:
- 1. Prime manufacturer: Specifications are based on equipment identified herein by manufacturer's name and model to establish minimal acceptable standards of quality, features, performance, and construction.
 - a. Macton/Joyce Corp., Oxford, CT (203) 267-1500
 - b. Model: Hi-Lift 10 Ton (set of 8)
 - 2. Alternate manufacturers: Contingent upon compliance with these specifications and documentation required set forth in Submittals, equipment produced by other manufacturers *may* be considered as equal.
 - a. Whiting Corp., Harvey, IL (708) 587-2100
- B. Capacities/Dimensions:
- 1. Overall dimensions:
 - a. Width: 31-1/2 inches
 - b. Depth: 42 inches
 - c. Height: 130 inches
 - 2. Screw diameter: 3-5/16 inches

3. Motor: 3 HP, each; total of 24 HP
4. Lift capacities: 10 tons each, 50 ton total
5. Lifting speed: 9 inches per minute
6. Effective lift: 70 inches
7. Minimum height: 6 inches

C. Features/Performance/Construction:

1. Base of lift shall be of steel construction.
2. Lifting carriage shall be guided by four (4) steel rollers within two (2) C shaped beam sections rollers that have anti-friction bearing lubrication for the life of the roller.
3. All lifts shall be designed for portability. This shall be accomplished by mounting the lifts on wheels that are deployed when the lift is at the full down position. The rear wheel shall be a steering wheel and controlled by a handle. When lifting, the lifts shall rest on the shop floor entirely on a base plate of sufficient design to carry the rated load.
4. Load bearing nut shall be made of bronze and shall followed by a steel safety nut. In the event of failure of the bronze load nut, the load is secured by the steel. A limit switch shall monitor the gap between the load-bearing nut and the safety nut.
5. Dual limit switches shall be located at the travel extremes of the lifting nut. The first limit switch is for primary operation and provides a signal for the PLC. The second switch is for over travel and is hard wired to the motor starter for the particular lift.
6. Manufacturer to verify with contractor the height of OCS wire prior to setting lift limit switches. Leave 12 inches from OCS wire to pantograph (to prevent vehicle from hitting OCS wire).
7. Four thermal protection relays (one per motor) shall be provided to protect the motors against short circuits and overload.
8. A programmable controller shall monitor the up and down motion of the lifting carriages and shall fault the system when the height difference reaches 1 inch and stop all the lifts.

D. Controls: The control system shall incorporate a set of eight lifts. Each set of eight lifts shall have one primary lift and seven secondary lifts.

1. Lift shall be equipped with NEMA 12 panel construction with heavy duty NEMA rated starters and push-button operation.
 - a. One "UP" push button (dead-man, constant pressure)
 - b. One "DOWN" push button (dead-man, constant pressure)
 - c. One "EMERGENCY STOP" push button (push-pull)
 - d. One "POWER" green pilot light
 - e. One two-position selector switch to operate the lifts INDIVIDUALLY or as a SYSTEM
2. Units shall have an interface panel which will provide for display for operating status and fault messages. The panel will also allow the operator or maintenance technician to perform diagnostics of the system to determine at a minimum:

- a. Travel limit switch status on all lifts.
 - b. Nut wear status on all lifts.
 - c. Screw rotation counter operation on all lifts.
 - d. Reset counter system for each lift.
 - e. Communication status between the PLC and remote input/output modules.
 - f. Status of Emergency Stop push button on each lift control station.
3. A fusible disconnect switch to control source power that will only allow the box to be opened if the switch is in the off position.
 4. Interconnecting cables with an oil resistant jacket shall be supplied to connect the Primary lift to the Secondary lifts, three (3) of each cable type per eight (8) lift system. The inter-lift power supply cable and the control cable shall be 50 feet in length and shall have a quick disconnect connector.
 5. A Secondary Control Box shall include NEMA type 12 (oil tight and dust tight) enclosure with receptacles for power cables, control cables, and for the pendant station.
 6. One (1) "UP-DOWN" pendent type push button station shall be supplied for every set of lifts. When the pendant station is plugged into a specific lift that lift becomes the master and all other connected lifts become slaves. Also when the pendent is plugged in individual control of each lift is disabled. Pendent enclosure shall be NEMA 12 (oil tight and dust tight) type.
 7. Motor shall be reversible electric.
 8. Each lifting unit shall be powered by a NEMA D electric motor. Each motor reducer shall be equipped with a electromechanical brake that is spring engaged when the motor is not running and is electrically released when either the "UP" and "DOWN" controls are energized.
 9. Safety Interlock with Electrified Overhead Contact Systems (OCS): Lift controls for both lifts shall be locked out whenever the OCS disconnect switched (DS2 and DS3) for those bays shall be locked out whenever either vehicle lift is being used or either vehicle is raised. Mechanical interlock system shall be Kirk Key or equal. Interlock system shall consist of the following:
 - a. Provide one mechanical key interlock on each lift control panel that will require the lift to be off and in a lowered positions before the key can be removed.
 - b. Provide one four-position mechanical transfer key interlock assembly compatible with the above, suitable for separate wall mounting, and containing locks for the following: OCS Disconnect Switch DS2 key, OCS Disconnect Switch DS3 key, Vehicle Lift Keys. Likewise, keys shall be held if either DS2 or DS3 key is removed (or both). Key information for DS2 and DS# locks shall be provided to City Contract Representative.
- E. Utility Requirements:
1. Electrical: 460 VAC, 3 phase, 3 HP motor (24 HP total for 8 lift columns)

- F. Finish: Heavy duty steel structure coated with one coat of rust inhibiting primer followed by two coats of yellow enamel.

2.03 LIFT, TABLE, BOGIE
Equipment Identifier: 5881

A. Manufacturer's Reference:

1. Prime manufacturer: Specifications are based on equipment identified herein by manufacturer's name and model to establish minimal acceptable standards of quality, features, performance, and construction.
 - a. Whiting Corp., Harvey, IL (708) 331-4000
 - b. Model: Bogie Lift Table
2. Alternate manufacturers: *Contingent upon compliance with these specifications* and documentation requirements set forth in SUBMITTALS, equipment produced by other manufacturers, including the following, *may* be considered as equal.

- B. Description: The rail guided Scissor lift shall be designed to travel under a raised vehicle, be positioned under a truck, raised to make contact with the truck and once the truck is disconnected from the rail vehicle, lower truck and transport it back from under the vehicle.

C. Capacities/Dimensions:

1. Overall dimensions: (dimensions to be field verified and coordinated)
 - a. Width: 120 inches
 - b. Depth: 68 inches
 - c. Height (not extended): 30 inches
 - d. Height (fully extended): 78 inches
2. Lifting speed: 30 inches per minute
3. Lifting capacity: 13,500 pounds

D. Features/Performance/Construction:

1. The rail guided scissor shall be designed to support, traverse, lift and lower a truck.
2. Steel plate decking shall come complete with 2 inch by 2 inch steel rails for supporting the truck.
3. Rail gauge spacing shall be 4 feet, 8-1/2 inches.
4. A set of two manually applied rail stops will be provided to allow the Operator to retain the truck in position.
5. A wobble plate shall be provided under the steel decking. When the locking pins are removed the wobble plate shall allow for a 1 foot +/- lateral play (90 degrees to rail). The wobble plate shall allow for fine lateral movement to align the truck back to the rail vehicle body. Final location for locking pins of wobble plate to be determined in the field.

6. The traversing of the lift shall be through battery power. The control of the traversing is through a hand held wireless pendent.
7. A battery charger shall be supplied for overnight re-charging of the system.

E. Utility Requirements:

1. Electrical: 120 VAC, 1 phase, 2 HP, 12.4 amps

F. Finish: Durable enamel in manufacturer's standard color

2.04 TURNTABLE, TRUCK ASSEMBLY

Equipment Identifier: 5950

A. Manufacturer's Reference:

1. Prime manufacturer: Specifications are based on equipment identified herein by manufacturer's name and model to establish minimal acceptable standards of quality, features, performance, and construction.
 - a. Whiting Corp., Harvey, IL (708) 331-4000
 - b. Model: Turntable
2. Alternate manufacturers: Contingent upon compliance with these specifications and documentation requirements set forth in Section 01300 Submittals, equipment produced by other manufacturers, including the following, *may* be considered as equal.
 - a. Macton/Joyce, Oxford, CT (203) 267-1500

B. Capacities/Dimensions:

1. Crossing capacity: 18,000 pounds in truck repair area
2. Rotating capacity: 18,000 pounds
3. Rotation: 360 degrees
4. Rail gauge: 4 feet, 8-1/2 inches
5. Turntable diameter: 10 feet

C. Features/Performance/Construction:

1. The turntable shall be constructed so entire structural assembly may be removed from the pit as a unit.
2. The table shall provide continuous ground capability of shop rails and turntable rails while also providing 360 degree rotation.
3. Negative return bonding to adjacent embedded rail shall be provided by a 750 volt dc, 500 ampere circuit, using a 360 degree collector ring mounted on the turntable with collector shoes mounted to the base frame.
4. Grounding wiring and insulation from the approach rails to the collector shoes and from rail to rail shall be provided.

5. Turntables shall be capable of being manually rotated to any one of four lockup positions by one man when supporting a two axle transit truck load of 18,000 pounds.
 6. The operator shall be able to rotate and lock/unlock the table from a telescoping leverage bar.
 7. The deck shall be designated to support a point load of 6,000 pounds anywhere, or a 300 pounds per square feet (psf) uniform load. Manufacturer shall provide access to bearings and pit drains.
 8. The turntable shall be designed with supports so that a deflection of 1/4 inch is not exceeded at the perimeter when the load is rolled on the table. Maximum deflection of any structural element shall not exceed 1/500 of its unsupported span.
 9. The basic structural design of the turntables shall include the following:
 - a. Center post shall provide a heavy-duty bearing assembly designed to carry the entire thrust and moment loading.
 - b. Structural frame shall be designed to provide a support for the transit vehicle running rails and top deck plate.
 - c. Top deck shall consist of a system of structural steel members spaced to provide adequate support for the diamond plate pattern steel deck plate.
 - d. Steel curb angle trim system: A rolled steel angle or steel tube shall be provided for embedment in the pit wall. Install in related concrete work as indicated. The gap between the fixed steel angle and the turntable shall not be more than 3/8 inch.
 - e. Rails: The shop rails shall be made with the turntable rails and shall be AREA Type 115RE or bar stock. The rail gauge shall be 4 feet, 8-1/2 inches. The table top shall be furnished with two sets of rails. The rails shall be centered on the table and intersect one another at 90 degrees.
- D. Finish: All equipment shall be rust free and all exposed surfaces shall be painted, with the exception of machined surfaces, with one coat of primer and two coats of paint in manufacturers standard colors

PART 3 - EXECUTION

3.01 INSPECTION

- A. Coordinate location of rough-in work and utility stub-outs to assure match with equipment to be installed.
- B. Inspect delivered equipment for damage from shipping and exposure to weather. Compare delivered equipment with packing lists and specifications to assure receipt of all equipment items and specified accessories.
- C. Report in writing to the Architect, any damaged, missing or incomplete scheduled equipment and improper rough-in or utility stub-outs.

3.02 INSTALLATION

- A. Perform work under direct supervision of Foreman of Construction Superintendent with authority to coordinate installation of scheduled equipment with Architect or designated representative.
- B. Install equipment in accordance with plans, shop drawings, and manufacturer's instructions:
 - 1. Positioning: Place equipment in accordance with any noted special positioning requirements generally level (or slight slope as required by instructions), plumb, and at right angles to adjacent work.
 - 2. Fitting: Where field cutting or trimming is necessary, perform in a neat, accurate, professional manner without damaging equipment or adjacent work.
 - 3. Anchorage: Attach equipment as directed by Architect or designated representative. Installation fasteners shall be installed to avoid scratching or damaging adjacent surfaces.
 - 4. Upon completion of work, finish surfaces shall be free of tool marks, scratches, blemishes, and stains.

3.03 TESTING

- A. After final connections are made and prior to authorizing payment, specified equipment shall be tested for compliance with specifications in the presence of the Architect or designated representative using acceptance procedures provided by the manufacturer.
- B. Each lift shall be tested with the vehicle types operated by the Owner.

3.04 CLEANUP

- A. Touch-up damage to painted finishes.
- B. Wipe and clean equipment of any oil, grease, and solvents, and make ready for use.
- C. Clean area around equipment installation and remove packing and installation debris from job site.
- D. Notify Architect or designated representative for acceptance inspection.

3.05 TRAINING

- A. Direct the technical representative to provide specified hours of training to designated Owner's maintenance personnel in operation and maintenance of the following equipment. Coordinate, with Owner, training schedule and list of personnel to be trained.
 - 1. 5432 Lift, parts, 3,000 pounds; 2 hours (minimum)
 - 2. 5876 Lift, portable, electric (set of 8); 4 hours (minimum)
 - 3. 5881 Lift, table, bogie; 2 hours (minimum)
 - 4. 5950 Turntable, truck assembly; 1 hour (minimum)

- B. Demonstrate each lift operation utilizing each of the vehicle types operated by Owner.
- C. Obtain, from technical representative, a list of Owner's personnel trained in equipment operations and maintenance.

END OF SECTION 14 45 00

SECTION 21 05 17**SLEEVES AND SLEEVE SEALS FOR FIRE-SUPPRESSION PIPING**

PART 1 - GENERAL

1.01. SUMMARY

- A. Section Includes:
 - 1. Sleeves.
 - 2. Sleeve-seal systems.
 - 3. Grout.

PART 2 - PRODUCTS

2.01. SLEEVES

- A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
- B. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.
- C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.
- D. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.
- E. Galvanized-Steel-Sheet Sleeves: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.

2.02. SLEEVE-SEAL SYSTEMS

- A. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
 - 1. Sealing Elements: EPDM-rubber or NBR interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 - 2. Pressure Plates: Stainless steel.
 - 3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.03. GROUT

- A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- B. Characteristics: Nonshrink; recommended for interior and exterior applications.
- C. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.01. SLEEVE INSTALLATION

- A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
- B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch (25-mm) annular clear space between piping and concrete slabs and walls.
 - 1. Sleeves are not required for core-drilled holes.
- C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches (50 mm) above finished floor level.
 - 2. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.
- D. Install sleeves for pipes passing through interior partitions.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - 2. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation.
 - 3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Section 07 92 00 "Joint Sealants."
- E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 07 84 13 "Penetration Firestopping."

3.02. SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.
- B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.03. SLEEVE AND SLEEVE-SEAL SCHEDULE

- A. Use sleeves and sleeve seals for the following piping-penetration applications:
 - 1. Exterior Concrete Walls above Grade: Cast-iron wall sleeves, Galvanized-steel wall sleeves or Galvanized-steel-pipe sleeves.
 - 2. Exterior Concrete Walls below Grade: Cast-iron wall sleeves with sleeve-seal system, Galvanized-steel wall sleeves with sleeve-seal system or Galvanized-steel-pipe sleeves with sleeve-seal system.
 - 3. Concrete Slabs above Grade: Galvanized-steel-pipe sleeves or PVC-pipe sleeves.
 - 4. Interior Partitions: Galvanized-steel-pipe sleeves or PVC-pipe sleeves.

END OF SECTION 21 05 17

SECTION 21 05 18**ESCUTCHEONS FOR FIRE-SUPPRESSION PIPING****PART 1 - GENERAL****1.01 SUMMARY**

- A. Section Includes:
 - 1. Escutcheons.
 - 2. Floor plates.

PART 2 - PRODUCTS**2.01 ESCUTCHEONS**

- A. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.
- C. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.

2.02 FLOOR PLATES

- A. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.

PART 3 - EXECUTION**3.01 INSTALLATION**

- A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.
- B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
 - 1. Escutcheons for New Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.

- b. Chrome-Plated Piping: One-piece, cast-brass type with polished, chrome-plated finish.
 - c. Insulated Piping: One-piece, stamped-steel type.
 - d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
 - e. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
 - f. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
 - g. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type.
 - h. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with rough-brass finish.
 - i. Bare Piping in Unfinished Service Spaces: One-piece, stamped-steel type.
 - j. Bare Piping in Equipment Rooms: One-piece, cast-brass type with polished, chrome-plated or rough-brass finish.
 - k. Bare Piping in Equipment Rooms: One-piece, stamped-steel type.
- C. Install floor plates for piping penetrations of equipment-room floors.
- D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
- 1. New Piping: One-piece, floor-plate type.

3.02 FIELD QUALITY CONTROL

- A. Replace broken and damaged escutcheons and floor plates using new materials.

END OF SECTION 21 05 18

SECTION 21 13 13

WET-PIPE SPRINKLER SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Pipes, fittings, and specialties.
2. Fire-protection valves.
3. Sprinklers.
4. Alarm devices.
5. Pressure gages.

1.02 SYSTEM DESCRIPTIONS

- A. Wet-Pipe Sprinkler System: Automatic sprinklers are attached to piping containing water and that is connected to water supply through alarm valve. Water discharges immediately from sprinklers when they are opened. Sprinklers open when heat melts fusible link or destroys frangible device. Hose connections are included if indicated.

1.03 PERFORMANCE REQUIREMENTS

- A. Standard-Pressure Piping System Component: Listed for **175-psig (1200-kPa)** minimum working pressure.
- B. Delegated Design: Design sprinkler system(s), including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
1. Available fire-hydrant flow test records (**1st and Holmes**) indicate the following conditions:
 - a. Date: 08/13.
 - b. Performed by: KCMO Water Service Department.
 - c. Location of Residual Fire Hydrant R: 3rd and Holmes.
 - d. Location of Flow Fire Hydrant F: 1st and Holmes.
 - e. Static Pressure at Residual Fire Hydrant R: 123 PSIG.
 - f. Measured Flow at Flow Fire Hydrant F: 1426 GPM.
 - g. Residual Pressure at Residual Fire Hydrant R: 108 PSIG.
 2. Available fire-hydrant flow test records (**3rd and Holmes**) indicate the following conditions:

- a. Date: 08/13.
 - b. Performed by: KCMO Water Service Department.
 - c. Location of Residual Fire Hydrant R: 1st and Holmes.
 - d. Location of Flow Fire Hydrant F: 3rd and Holmes.
 - e. Static Pressure at Residual Fire Hydrant R: 140 PSIG.
 - f. Measured Flow at Flow Fire Hydrant F: 1665 GPM.
 - g. Residual Pressure at Residual Fire Hydrant R: 118 PSIG.
- C. Sprinkler system design shall be approved by authorities having jurisdiction.
1. Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through water-service piping, valves, and backflow preventers.
 2. Sprinkler Occupancy Hazard Classifications:
 - a. Building Service Areas: Ordinary Hazard, Group 1.
 - b. Electrical Equipment Rooms: Ordinary Hazard, Group 1.
 - c. General Storage Areas: Ordinary Hazard, Group 1.
 - d. Machine Shops: Ordinary Hazard, Group 2.
 - e. Mechanical Equipment Rooms: Ordinary Hazard, Group 1.
 - f. Office and Public Areas: Light Hazard.
 - g. Repair Garages: Ordinary Hazard, Group 2.
 3. Minimum Density for Automatic-Sprinkler Piping Design:
 - a. Light-Hazard Occupancy: 0.10 gpm over 1500-sq. ft. (4.1 mm/min. over 139-sq. m) area.
 - b. Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm over 1500-sq. ft. (6.1 mm/min. over 139-sq. m) area.
 - c. Ordinary-Hazard, Group 2 Occupancy: 0.20 gpm over 1500-sq. ft. (8.1 mm/min. over 139-sq. m) area.
 - d. Extra-Hazard, Group 1 Occupancy: 0.30 gpm over 2500-sq. ft. (12.2 mm/min. over 232-sq. m) area.
 - e. Extra-Hazard, Group 2 Occupancy: 0.40 gpm over 2500-sq. ft. (16.3 mm/min. over 232-sq. m) area.
 - f. Special Occupancy Hazard: As determined by authorities having jurisdiction.
 4. Maximum Protection Area per Sprinkler: Per UL listing.
 5. Maximum Protection Area per Sprinkler:
 - a. Office Spaces: 225 sq. ft. (20.9 sq. m).
 - b. Storage Areas: 130 sq. ft. (12.1 sq. m).
 - c. Mechanical Equipment Rooms: 130 sq. ft. (12.1 sq. m).
 - d. Electrical Equipment Rooms: 130 sq. ft. (12.1 sq. m).
 - e. Other Areas: According to NFPA 13 recommendations unless otherwise indicated.
 6. Total Combined Hose-Stream Demand Requirement: According to NFPA 13 unless otherwise indicated:

- a. Light-Hazard Occupancies: 100 gpm (6.3 L/s) for 30 minutes.
 - b. Ordinary-Hazard Occupancies: 250 gpm (15.75 L/s) for 60 to 90 minutes.
 - c. Extra-Hazard Occupancies: 500 gpm (31.5 L/s) for 90 to 120 minutes.
- D. Seismic Performance: Sprinkler piping shall withstand the effects of earthquake motions determined according to NFPA 13 and ASCE/SEI 7.

1.04 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For wet-pipe sprinkler systems. Include plans, elevations, sections, details, and attachments to other work.
 1. Wiring Diagrams: For power, signal, and control wiring.
- C. Delegated-Design Submittal: For sprinkler systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- D. Qualification Data: For qualified Installer and professional engineer.
- E. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations if applicable.
- F. Welding certificates.
- G. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractor's Material and Test Certificate for Aboveground Piping."
- H. Field quality-control reports.
- I. Operation and maintenance data.

1.05 QUALITY ASSURANCE

- A. Installer Qualifications:
 1. Installer's responsibilities include designing, fabricating, and installing sprinkler systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.

- a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer.
- B. Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. NFPA Standards: Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with the following:
 - 1. NFPA 13, "Installation of Sprinkler Systems."
 - 2. NFPA 24, "Installation of Private Fire Service Mains and Their Appurtenances."

PART 2 - PRODUCTS

2.01 PIPING MATERIALS

- A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, and fitting materials, and for joining methods for specific services, service locations, and pipe sizes.

2.02 STEEL PIPE AND FITTINGS

- A. Standard Weight, Black-Steel Pipe: ASTM A 53/A 53M, Type E, Grade B. Pipe ends may be factory or field formed to match joining method.
- B. Schedule 30, Black-Steel Pipe: ASTM A 135; ASTM A 795/A 795M, Type E; or ASME B36.10M, wrought steel; with wall thickness not less than Schedule 30 and not more than Schedule 40. Pipe ends may be factory or field formed to match joining method.
- C. Thinwall Black-Steel Pipe: ASTM A 135 or ASTM A 795/A 795M, threadable, with wall thickness less than Schedule 30 and equal to or greater than Schedule 10. Pipe ends may be factory or field formed to match joining method.
- D. Black-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M, standard-weight, seamless steel pipe with threaded ends.

PRODUCT DATA SHEET 1 - Uncoated, Steel Couplings: ASTM A 865, threaded.

- A. Uncoated, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.

- B. Malleable- or Ductile-Iron Unions: UL 860.
- C. Cast-Iron Flanges: ASME 16.1, Class 125.
- D. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.
- E. Steel Welding Fittings: ASTM A 234/A 234M and ASME B16.9.
- F. Grooved-Joint, Steel-Pipe Appurtenances:
 - 1. Pressure Rating: **175 psig (1200 kPa)** minimum.
 - 2. Uncoated, Grooved-End Fittings for Steel Piping: ASTM A 47/A 47M, malleable-iron casting or ASTM A 536, ductile-iron casting; with dimensions matching steel pipe.
 - 3. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213, rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and bolts and nuts.
- G. Steel Pressure-Seal Fittings: UL 213, FM-approved, **175-psig (1200-kPa)** pressure rating with steel housing, rubber O-rings, and pipe stop; for use with fitting manufacturers' pressure-seal tools.

2.02 PIPING JOINING MATERIALS

- A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, **1/8 inch (3.2 mm)** thick or ASME B16.21, nonmetallic and asbestos free.
 - 1. Class 125, Cast-Iron Flat-Face Flanges: Full-face gaskets.
- B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
- C. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.03 LISTED FIRE-PROTECTION VALVES

- A. General Requirements:
 - 1. Valves shall be UL listed or FM approved.
 - 2. Minimum Pressure Rating: **175 psig (1200 kPa)**.
- B. Check Valves:

1. Standard: UL 312.
2. Pressure Rating: 250 psig (1725 kPa) minimum.
3. Type: Swing check.
4. Body Material: Cast iron.
5. End Connections: Flanged or grooved.

C. Bronze OS&Y Gate Valves:

1. Standard: UL 262.
2. Pressure Rating: 175 psig (1200 kPa).
3. Body Material: Bronze.
4. End Connections: Threaded.

D. Iron OS&Y Gate Valves:

1. Standard: UL 262.
2. Pressure Rating: 250 psig (1725 kPa) minimum.
3. Body Material: Cast or ductile iron.
4. End Connections: Flanged or grooved.

E. Indicating-Type Butterfly Valves:

1. Standard: UL 1091.
2. Pressure Rating: 175 psig (1200 kPa) minimum.
3. Valves NPS 2 (DN 50) and Smaller:
 - a. Valve Type: Ball or butterfly.
 - b. Body Material: Bronze.
 - c. End Connections: Threaded.
4. Valves NPS 2-1/2 (DN 65) and Larger:
 - a. Valve Type: Butterfly.
 - b. Body Material: Cast or ductile iron.
 - c. End Connections: Flanged, grooved, or wafer.
5. Valve Operation: Integral electrical, 115-V ac, prewired, two-circuit, supervisory switch indicating device.

2.04 TRIM AND DRAIN VALVES

A. General Requirements:

1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
2. Minimum Pressure Rating: 175 psig (1200 kPa).

B. Ball Valves:

2.05 SPECIALTY VALVES

A. General Requirements:

1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
2. Minimum Pressure Rating: 175 psig (1200 kPa).
3. Body Material: Cast or ductile iron.
4. Size: Same as connected piping.
5. End Connections: Flanged or grooved.

B. Alarm Valves:

1. Standard: UL 193.
2. Design: For horizontal or vertical installation.
3. Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gages, retarding chamber, and fill-line attachment with strainer.
4. Drip Cup Assembly: Pipe drain without valves and separate from main drain piping.
5. Drip Cup Assembly: Pipe drain with check valve to main drain piping.

C. Automatic (Ball Drip) Drain Valves:

1. Standard: UL 1726.
2. Pressure Rating: 175 psig (1200 kPa) minimum.
3. Type: Automatic draining, ball check.
4. Size: NPS 3/4 (DN 20).
5. End Connections: Threaded.

2.06 SPRINKLER SPECIALTY PIPE FITTINGS

A. Branch Outlet Fittings:

1. Standard: UL 213.
2. Pressure Rating: 175 psig (1200 kPa) minimum.
3. Body Material: Ductile-iron housing with EPDM seals and bolts and nuts.
4. Type: Mechanical-T and -cross fittings.
5. Configurations: Snap-on and strapless, ductile-iron housing with branch outlets.
6. Size: Of dimension to fit onto sprinkler main and with outlet connections as required to match connected branch piping.
7. Branch Outlets: Grooved, plain-end pipe, or threaded.

B. Flow Detection and Test Assemblies:

1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
2. Pressure Rating: 175 psig (1200 kPa) minimum.

3. Body Material: Cast- or ductile-iron housing with orifice, sight glass, and integral test valve.
4. Size: Same as connected piping.
5. Inlet and Outlet: Threaded.

C. Branch Line Testers:

1. Standard: UL 199.
2. Pressure Rating: 175 psig (1200 kPa) minimum.
3. Body Material: Brass.
4. Size: Same as connected piping.
5. Inlet: Threaded.
6. Drain Outlet: Threaded and capped.
7. Branch Outlet: Threaded, for sprinkler.

D. Sprinkler Inspector's Test Fittings:

1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
2. Pressure Rating: 175 psig (1200 kPa) minimum.
3. Body Material: Cast- or ductile-iron housing with sight glass.
4. Size: Same as connected piping.
5. Inlet and Outlet: Threaded.

E. Adjustable Drop Nipples:

1. Standard: UL 1474.
2. Pressure Rating: 250 psig (1725 kPa) minimum.
3. Body Material: Steel pipe with EPDM-rubber O-ring seals.
4. Size: Same as connected piping.
5. Length: Adjustable.
6. Inlet and Outlet: Threaded.

F. Flexible, Sprinkler Hose Fittings:

1. Standard: UL 1474.
2. Type: Flexible hose for connection to sprinkler, and with bracket for connection to ceiling grid.
3. Pressure Rating: 175 psig (1200 kPa) minimum.
4. Size: Same as connected piping, for sprinkler.

2.07 SPRINKLERS

A. General Requirements:

1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
2. Pressure Rating for Residential Sprinklers: 175 psig (1200 kPa) maximum.

3. Pressure Rating for Automatic Sprinklers: 175 psig (1200 kPa) minimum.
 4. Pressure Rating for High-Pressure Automatic Sprinklers: 250 psig (1725 kPa) minimum.
- B. Automatic Sprinklers with Heat-Responsive Element:
1. Early-Suppression, Fast-Response Applications: UL 1767.
 2. Nonresidential Applications: UL 199.
 3. Characteristics: Nominal 1/2-inch (12.7-mm) orifice with Discharge Coefficient K of 5.6, and for "Ordinary" temperature classification rating unless otherwise indicated or required by application.
- C. Sprinkler Finishes:
1. Chrome plated.
 2. Bronze.
 3. Painted.
- D. Special Coatings:
1. Wax.
 2. Lead.
 3. Corrosion-resistant paint.
- E. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.
1. Ceiling Mounting: Chrome-plated steel, two piece, with 1-inch (25-mm) vertical adjustment.
 2. Sidewall Mounting: Chrome-plated steel, one piece, flat.
- F. Sprinkler Guards:
1. Standard: UL 199.
 2. Type: Wire cage with fastening device for attaching to sprinkler.
- 2.08 ALARM DEVICES
- A. Alarm-device types shall match piping and equipment connections. Provide horn and strobe where indicated on the drawings.
- B. Electric Operated Alarm: Per NFPA
- C. Water-Flow Indicators:
1. Standard: UL 346.
 2. Water-Flow Detector: Electrically supervised.
 3. Components: Two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-

set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.

4. Type: Paddle operated.
5. Pressure Rating: 250 psig (1725 kPa).
6. Design Installation: Horizontal or vertical.

D. Valve Supervisory Switches:

1. Standard: UL 346.
2. Type: Electrically supervised.
3. Components: Single-pole, double-throw switch with normally closed contacts.
4. Design: Signals that controlled valve is in other than fully open position.

2.09 PRESSURE GAGES

- A. Standard: UL 393.
- B. Dial Size: 3-1/2- to 4-1/2-inch (90- to 115-mm) diameter.
- C. Pressure Gage Range: 0 to 250 psig (0 to 1725 kPa) minimum.
- D. Water System Piping Gage: Include "WATER" or "AIR/WATER" label on dial face.

PART 3 - EXECUTION

3.01 SERVICE-ENTRANCE PIPING

- A. Connect sprinkler piping to water-service piping for service entrance to building. Comply with requirements per KCMO water Department and local Fire Marshall.
- B. Install shutoff gate valve, detector check backflow preventer, pressure gage, drain, and other accessories indicated at connection to water-service piping.

3.02 PIPING INSTALLATION

- A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.
 1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.

- B. Piping Standard: Comply with requirements for installation of sprinkler piping in NFPA 13.
- C. Install seismic restraints on piping. Comply with requirements for seismic-restraint device materials and installation in NFPA 13.
- D. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
- E. Install unions adjacent to each valve in pipes **NPS 2 (DN 50)** and smaller.
- F. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having **NPS 2-1/2 (DN 65)** and larger end connections.
- G. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13.
- H. Install sprinkler piping with drains for complete system drainage.
- I. Install sprinkler control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.
- J. Install automatic (ball drip) drain valve at each check valve for fire-department connection, to drain piping between fire-department connection and check valve. Install drain piping to and spill over floor drain or to outside building.
- K. Install alarm devices in piping systems.
- L. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements for hanger materials in NFPA 13.
- M. Install pressure gages on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gages with connection not less than **NPS 1/4 (DN 8)** and with soft metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they will not be subject to freezing.
- N. Fill sprinkler system piping with water.
- O. Install electric heating cables and pipe insulation on sprinkler piping in areas subject to freezing. Comply with requirements for heating cables in Section 21 05 33 "Heat Tracing for Fire-Suppression Piping" and for piping insulation in Section 21 07 00 "Fire-Suppression Systems Insulation."

- P. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 21 05 17 "Sleeves and Sleeve Seals for Fire-Suppression Piping."
- Q. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 21 05 17 "Sleeves and Sleeve Seals for Fire-Suppression Piping."
- R. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 21 05 18 "Escutcheons for Fire-Suppression Piping."

3.03 JOINT CONSTRUCTION

- A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.
- B. Install unions adjacent to each valve in pipes **NPS 2 (DN 50)** and smaller.
- C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having **NPS 2-1/2 (DN 65)** and larger end connections.
- D. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- E. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- F. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.
- G. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- H. Twist-Locked Joints: Insert plain end of steel pipe into plain-end-pipe fitting. Rotate retainer lugs one-quarter turn or tighten retainer pin.
- I. Steel-Piping, Pressure-Sealed Joints: Join lightwall steel pipe and steel pressure-seal fittings with tools recommended by fitting manufacturer.

- J. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.
 - 1. Shop weld pipe joints where welded piping is indicated. Do not use welded joints for galvanized-steel pipe.
- K. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints.
- L. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.
- M. Steel-Piping, Pressure-Sealed Joints: Join Schedule 5 steel pipe and steel pressure-seal fittings with tools recommended by fitting manufacturer.
- N. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.04 VALVE AND SPECIALTIES INSTALLATION

- A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 13 and authorities having jurisdiction.
- B. Install listed fire-protection shutoff valves supervised open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.
- C. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.
- D. Specialty Valves:
 - 1. General Requirements: Install in vertical position for proper direction of flow, in main supply to system.
 - 2. Alarm Valves: Include bypass check valve and retarding chamber drain-line connection.

3.05 SPRINKLER INSTALLATION

- A. Install sprinklers in suspended ceilings in center of narrow dimension of acoustical ceiling panels.
- B. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing.

- C. Install sprinklers into flexible, sprinkler hose fittings and install hose into bracket on ceiling grid.

3.06 IDENTIFICATION

- A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.
- B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

3.07 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - 3. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
 - 4. Energize circuits to electrical equipment and devices.
 - 5. Coordinate with fire-alarm tests. Operate as required.
 - 6. Coordinate with fire-pump tests. Operate as required.
 - 7. Verify that equipment hose threads are same as local fire-department equipment.
- C. Sprinkler piping system will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

3.08 CLEANING

- A. Clean dirt and debris from sprinklers.
- B. Remove and replace sprinklers with paint other than factory finish.

3.09 PIPING SCHEDULE

- A. Piping between Fire-Department Connections and Check Valves: Galvanized, standard-weight steel pipe with threaded ends; cast-iron threaded fittings; and

threaded, grooved ends; grooved-end fittings; grooved-end-pipe couplings; and grooved joints.

- B. Sprinkler specialty fittings may be used, downstream of control valves, instead of specified fittings.
- C. Wet-pipe sprinkler system, **NPS 2 (DN 50)** and smaller, shall be one of the following:
 - 1. Standard-weight or Schedule 30, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
 - 2. Standard-weight or Schedule 30, black-steel pipe with plain ends; uncoated, plain-end-pipe fittings; and twist-locked joints.
 - 3. Standard-weight or Schedule 30, black-steel pipe with cut- or roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
 - 4. Standard-weight Schedule 30, black-steel pipe with plain ends; steel welding fittings; and welded joints.
 - 5. Thinwall black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
 - 6. Thinwall black-steel pipe with plain ends; uncoated, plain-end-pipe fittings; and twist-locked joints.
 - 7. Thinwall black-steel pipe with plain ends; welding fittings; and welded joints.
- D. Standard-pressure, wet-pipe sprinkler system, **NPS 2-1/2 to NPS 6 (DN 65 to DN 150)**, shall be one of the following:
 - 1. Standard-weight or Schedule 30, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
 - 2. Standard-weight or Schedule 30], black-steel pipe with cut- or roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
 - 3. Standard-weight or Schedule 30, black-steel pipe with plain ends; steel welding fittings; and welded joints.
 - 4. Thinwall black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
 - 5. Thinwall black-steel pipe with plain ends; welding fittings; and welded joints.

3.10 SPRINKLER SCHEDULE

- A. Use sprinkler types in subparagraphs below for the following applications:
 - 1. Rooms without Ceilings: Upright sprinklers.
 - 2. Rooms with Suspended Ceilings: Pendent, recessed, flush, and concealed sprinklers as required.
 - 3. Wall Mounting: Sidewall sprinklers.
 - 4. Special Applications: Extended-coverage, flow-control, and quick-response sprinklers.

B. Provide sprinkler types in subparagraphs below with finishes indicated.

1. Concealed Sprinklers: Rough brass, with factory-painted white cover plate.
2. Flush Sprinklers: Bright chrome, with painted white escutcheon.
3. Recessed Sprinklers: Bright chrome, with bright chrome escutcheon.
4. Residential Sprinklers: Dull chrome.
5. Upright, Pendent and Sidewall Sprinklers: Chrome plated in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view; wax coated where exposed to acids, chemicals, or other corrosive fumes.

END OF SECTION 21 13 13

SECTION 21 21 13.16**CLEAN AGENT FIRE-EXTINGUISHING SYSTEMS****PART 1 - GENERAL****1.01 SUMMARY****A. Section Includes:**

1. Clean agent.
2. Piping.
3. Flexible-hose connectors.
4. Insulated carbon-dioxide containers.
5. Distribution valves.
6. Discharge nozzles.
7. Hangers and supports.
8. Control panels.
9. Detection devices.
10. Manual stations.
11. Switches.
12. Alarm devices.

1.02 ACTION SUBMITTALS**A. Product Data:** For each type of product.**B. Shop Drawings:** For low-pressure clean agent fire-extinguishing system signed and sealed by a qualified professional engineer.

1. Include plans, elevations, sections, and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

1.03 INFORMATIONAL SUBMITTALS**A. Permit-Approved Drawings:** Working plans including design calculations, prepared according to NFPA 12, that have been approved by authorities having jurisdiction.**B. Seismic Qualification Certificates:** For container foundations, container racks, supports, hangers, braces, accessories, and components, from manufacturer.

1. **Basis for Certification:** Indicate whether withstand certification is based on actual test of assembled components or on calculation.

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control reports.

1.04 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For clean agent fire-extinguishing system to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.01 SYSTEM DESCRIPTION

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Fike Corporation.

- B. Total-Flooding System: Pre-engineered clean agent fire-extinguishing system designed for total flooding of the hazard area including the room cavity above the ceiling and below the ceiling.

- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

- D. NFPA Compliance: Fire-extinguishing system, equipment, and components shall comply with NFPA 12.

2.02 PERFORMANCE REQUIREMENTS

- A. Total-Flooding System Design Criteria:

1. Hazards: Electrical equipment room.
2. Discharge clean agent for 60 seconds and maintain 34 percent concentration by volume at 70 deg F (21 deg C) for 10 minute holding time in hazard areas.
3. Operations and Controls: If smoke is detected below the ceiling, extinguishing agent shall be discharged. If smoke is detected above the ceiling, extinguishing agent shall be discharged in the zone above the ceiling only.

- B. Seismic Performance: Container foundations, supports, hangers, and braces shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the system will remain in place without separation of any parts when subjected to the seismic forces specified and the system will be fully operational after the seismic event."
 2. Component Importance Factor is 1.5.
- C. Design clean agent fire-extinguishing system and obtain approval from authorities having jurisdiction. Design system for TPSS SI Equipment Room as appropriate for areas being protected and include safety factor.
- 2.03 CLEAN AGENT
- A. HFC-227ea or FM200..
- 2.04 PIPING MATERIALS
- A. Piping, Valves, and Discharge Nozzles: Comply with types and standards listed in NFPA 12, Section "Distribution," for charging pressure of system.
- 2.05 PIPES AND FITTINGS
- A. Steel Pipe: ASTM A 53/A 53M, Schedule 40, Grade B, Type E or ASTM A 106/A 106M, Grade A, black finish, seamless-steel pipe.
1. Threaded Fittings:
 - a. Malleable-Iron Fittings: ASME B16.3, Class 300.
 - b. Flanges and Flanged Fittings: ASME B16.5, Class 300.
- 2.06 FLEXIBLE-HOSE CONNECTORS
- A. Description: Teflon-lined, braided hose with stainless-steel wire-braid covering.
1. Design Standard: ASME B31.1.
 2. Internal Pressure: 450 psi (3101 kPa).
 3. Burst Pressure: 1800 psi (12 411 kPa) minimum.
 4. End Connections: Threaded male couplings.
- 2.07 INSULATED CLEAN AGENT CONTAINERS
- A. Containers:
1. Minimum Manufacturing Standard: ASME Boiler & Pressure Vessel Code, Section VIII, Division 1.
 2. Housing: Steel.
 3. Working Pressure: 363 psi (2503 kPa).
 4. Maintenance Pressure Requirements: 300 psi (2068 kPa) and 0 deg F (minus 18 deg C) with a design pressure of 325 psi (2241 kPa).

5. Bulk System Storage Container Nominal Size: 3/4 ton (680 kg).
6. Mini-Bulk System Storage Container Nominal Size: 800 lb (363 kg).

B. Valves:

1. Manual shutoff valve.
2. Bleeder Valve: 341 psi (2352 kPa).
3. Relief Valve: 357 psi (2462 kPa).

C. Gages:

1. Liquid level.
2. Pressure.

D. High- and Low-Pressure Supervisory Alarm:

1. Maximum Pressure Set Point: 90 percent of allowable working pressure.
2. Minimum Pressure Set Point: 250 psi (1724 kPa).

E. Refrigeration System:

1. Maintenance Pressure: 300 psi (2068 kPa) at maximum expected temperature.
2. Pressure Switch:
 - a. Start Pressure: 295 psi (2034 kPa).
 - b. Stop Pressure: 305 psi (2103 kPa).
3. Compressor: Commercial grade.
4. Refrigeration Coil Location: Lengthwise near top.
5. Motor:
 - a. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements
 - b. Efficiency: Premium efficient.
 - c. Electrical Characteristics:
 - 1) Horsepower: As required.
 - 2) Volts: 120.
 - 3) Phase: Single.
 - 4) Hertz: 60.

F. Heating System:

1. Maintenance Temperature: 32 deg F (0 deg C) at minimum expected temperature.

2.08 DISTRIBUTION VALVES

A. Selector Valve:

1. Actuation: Pneumatic, electro pneumatic, or manual.

2. Design: Ball or Butterfly with spring-return actuator.
 - a. Minimum Burst Pressure: 5000 psi (34 474 kPa).
 - b. Minimum Pressure without Permanent Distortion: 1800 psi (12 411 kPa).

B. Master Valve:

1. Actuation: Pneumatic, electro pneumatic, or manual.
2. Design: Ball or butterfly, with spring-return actuator.
 - a. Minimum burst pressure: 5000 psi (34 474 kPa).
 - b. Minimum pressure without permanent distortion: 1800 psi (12 411 kPa).

2.09 DISCHARGE NOZZLES

- A. Equipment manufacturer's standard material of working pressure, size, discharge pattern, and capacity required for application.
- B. Corrosion-resistant metal.
- C. Stamped with orifice size and type.

2.10 HANGERS AND SUPPORTS

- A. Carbon-Steel Pipe Hangers and Supports:
 1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
 2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
 3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
 4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
 5. Hanger Rods: Continuous-thread rod with compatible nuts and washers.

2.11 CONTROL PANELS

- A. Description: FM Approved or listed and labeled by a nationally recognized testing agency acceptable to authorities having jurisdiction, including equipment and features required for testing, supervising, and operating fire-extinguishing system.
- B. Power Requirements: 120/240-V ac; with electrical contacts for connection to system components and fire-alarm system, and transformer or rectifier as needed to produce power at voltage required for accessories and alarm devices.

2.12 DETECTION DEVICES

- A. General Requirements for Detection Devices:
 1. Comply with NFPA 12, NFPA 72, and UL 268.

2. 24-V dc, nominal.

- B. Ionization Detectors: Dual-chamber type, having sampling and referencing chambers, with smoke-sensing element.
- C. Photoelectric Detectors: LED light source and silicon photodiode receiving element.

2.13 MANUAL STATIONS

- A. Description: Surface, FM Approved or listed and labeled by a nationally recognized testing agency acceptable to authorities having jurisdiction, with clear plastic hinged cover, 120-V ac or low voltage compatible with controls. Include contacts for connection to control panel.
- B. Manual Release: "MANUAL RELEASE" caption, with red finish. Unit can manually discharge extinguishing agent with operating device that remains engaged until unlocked.
- C. Abort Switch: "ABORT" caption, momentary contact, with green finish.
- D. EPO Switch: "EPO" caption, with yellow finish.

2.14 SWITCHES

- A. Description: FM Approved or listed and labeled by a nationally recognized testing agency acceptable to authorities having jurisdiction.
 - 1. Control Voltage: 120-V ac compatible with controls.
 - 2. Include contacts for connection to control panel.
 - 3. Discharge Pressure Switches: Pneumatic operation for shutdown of equipment.
 - 4. Power Transfer Switches: Key-operation selector for transfer of release circuit signal from main supply to reserve supply.
 - 5. Door Closers: Magnetic retaining and release device or electrical interlock to cause the door operator to drive the door closed.

2.15 ALARM DEVICES

- A. Description: FM Approved or listed and labeled by a nationally recognized testing agency acceptable to authorities having jurisdiction; low voltage and surface mounting.
- B. Comply with requirements in Section 28 31 11 "Digital, Addressable Fire-Alarm System" for alarm and monitoring devices.
- C. Bells: Minimum 6-inch (150-mm) diameter.
- D. Horns: 90 to 94 dBA.
- E. Strobe Lights: Translucent lens, with "FIRE" or similar caption.

PART 3 - EXECUTION**3.01 INSTALLATION**

- A. Comply with requirements in NFPA 12.

3.02 HANGERS AND SUPPORTS

- A. Field fabricate hangers and supports from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- B. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- C. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- D. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- E. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, **NPS 2-1/2 (DN 65)** and larger, and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- F. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- G. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes to facilitate draining moisture and to not exceed maximum pipe deflections allowed by ASME B31.9 for building-services piping.
- H. Install carbon-steel hangers and supports for steel piping.
- I. Vertical Piping: MSS Type 8 or 42, clamps.
- J. Individual, Straight, Horizontal Piping Runs:
 - 1. **100 Feet (30 m)** and Less: MSS Type 1, adjustable, steel, clevis hangers.
 - 2. Longer Than **100 Feet (30 m)**: MSS Type 43, adjustable, roller hangers.
- K. Base of Vertical Piping: MSS Type 52, spring hangers.
- L. Support horizontal piping within **12 inches (300 mm)** of each fitting and coupling.
- M. Rod diameter may be reduced one size for double-rod hangers, with **3/8-inch- (10-mm-)** minimum rods.
- N. Maximum Span between Hangers and Piping with Threaded or Welded Joints:

1. NPS 1/4 to NPS 1/2 (DN 8 to DN 15): 60 inches (1500 mm) with 3/8-inch (10-mm) rod.
2. NPS 3/4 (DN 20): 72 inches (1800 mm) with 3/8-inch (10-mm) rod.
3. NPS 1 (DN 25): 84 inches (2100 mm) with 3/8-inch (10-mm) rod.
4. NPS 1-1/4 (DN 32): 96 inches (2400 mm) with 3/8-inch (10-mm) rod.
5. NPS 1-1/2 (DN 40): 108 inches (2700 mm) with 3/8-inch (10-mm) rod.
6. NPS 2 (DN 50): 10 feet (3 m) with 3/8-inch (10-mm) rod.
7. NPS 2-1/2 (DN 65): 11 feet (3.4 m) with 3/8-inch (10-mm) rod.
8. NPS 3 (DN 80): 12 feet (3.6 m) with 1/2-inch (13-mm) rod.
9. NPS 4 (DN 100): 14 feet (4.3 m) with 1/2-inch (13-mm) rod.

O. Maximum Span between Hangers and Piping with Mechanical Joints:

1. NPS 3/4 to NPS 2 (DN 20 to DN 50): 84 inches (2100 mm) with 3/8-inch (10-mm) rod.
2. NPS 3 to NPS 4 (DN 80 to DN 100): 10 feet (3 m) with 3/8-inch (10-mm) rod.

P. Install seismic restraints on piping.

3.03 IDENTIFICATION

- A. Identify piping, extinguishing-agent containers, other equipment, and panels according to NFPA 12.
- B. Install signs at entry doors for protected areas to warn occupants that they are entering a room protected by a carbon-dioxide fire-extinguishing system.
- C. Install signs at entry doors to advise persons outside the room of the meaning of the horn(s), bell(s), and strobe light(s) outside the protected space.

3.04 FIELD QUALITY CONTROL

- A. Perform tests and inspections according to NFPA 12.
- B. Carbon-dioxide fire-extinguishing system will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

3.05 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain clean agent fire-extinguishing system.

END OF SECTION 21 21 13.16

SECTION 22 05 17**SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING****PART 1 - GENERAL****1.01 SUMMARY**

- A. Section Includes:
1. Sleeves.
 2. Sleeve-seal systems.
 3. Grout.

PART 2 - PRODUCTS**2.01 SLEEVES**

- A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
- B. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.
- C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.
- D. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.
- E. Galvanized-Steel-Sheet Sleeves: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.

2.02 SLEEVE-SEAL SYSTEMS

- A. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
1. Sealing Elements: EPDM-rubber or NBR interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 2. Pressure Plates: Stainless steel.
 3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.03 GROUT

- A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- B. Characteristics: Nonshrink; recommended for interior and exterior applications.
- C. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.01 SLEEVE INSTALLATION

- A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
- B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch (25-mm) annular clear space between piping and concrete slabs and walls.
 - 1. Sleeves are not required for core-drilled holes.
- C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches (50 mm) above finished floor level.
 - 2. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.
- D. Install sleeves for pipes passing through interior partitions.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - 2. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation.
 - 3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Section 07 92 00 "Joint Sealants."
- E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 07 84 13 "Penetration Firestopping."

3.02 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.
- B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.03 SLEEVE AND SLEEVE-SEAL SCHEDULE

- A. Use sleeves and sleeve seals for the following piping-penetration applications:
 - 1. Exterior Concrete Walls above Grade:
 - a. Cast-iron wall sleeves, Galvanized-steel wall sleeves or Galvanized-steel-pipe sleeves.
 - 2. Exterior Concrete Walls below Grade:
 - a. Cast-iron wall sleeves with sleeve-seal system, Galvanized-steel wall sleeves with sleeve-seal system or Galvanized-steel-pipe sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.
 - 3. Concrete Slabs-on-Grade:
 - a. Cast-iron wall sleeves with sleeve-seal system, Galvanized-steel wall sleeves with sleeve-seal system, or Galvanized-steel-pipe sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.
 - 4. Concrete Slabs above Grade:
 - a. Galvanized-steel-pipe sleeves.
 - 5. Interior Partitions:
 - a. Galvanized-steel-pipe sleeves.

END OF SECTION 22 05 17

SECTION 22 05 18
ESCUTCHEONS FOR PLUMBING PIPING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
1. Escutcheons.
 2. Floor plates.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

PART 2 - PRODUCTS

2.01 ESCUTCHEONS

- A. One-Piece, Cast-Brass Type: With polished, chrome-plated rough-brass finish and setscrew fastener.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.
- C. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.

2.02 FLOOR PLATES

- A. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.
- B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
1. Escutcheons for New Piping:

- a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
 - b. Chrome-Plated Piping: One-piece, cast-brass type with polished, chrome-plated finish.
 - c. Insulated Piping: One-piece, stamped-steel type.
 - d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
 - e. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
 - f. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
 - g. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type.
 - h. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished, chrome-plated or rough-brass finish.
 - i. Bare Piping in Unfinished Service Spaces: One-piece, stamped-steel type.
 - j. Bare Piping in Equipment Rooms: One-piece, cast-brass type with polished, chrome-plated or rough-brass finish.
 - k. Bare Piping in Equipment Rooms: One-piece, stamped-steel type.
- C. Install floor plates for piping penetrations of equipment-room floors.
- D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
1. New Piping: One-piece, floor-plate type.

3.02 FIELD QUALITY CONTROL

- A. Replace broken and damaged escutcheons and floor plates using new materials.

END OF SECTION 22 05 18

SECTION 22 05 19**METERS AND GAGES FOR PLUMBING PIPING**

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Bimetallic-actuated thermometers.
 - 2. Liquid-in-glass thermometers.
 - 3. Thermowells.
 - 4. Dial-type pressure gages.
 - 5. Gage attachments.

1.02 SUBMITTALS

- A. Product Data: thermometers and pressure gages
- B. Product certificates.
- C. Operation and maintenance data.

PART 2 - PRODUCTS

2.01 BIMETALLIC-ACTUATED THERMOMETERS

- A. Standard: ASME B40.200.
- B. Case: Liquid-filled and sealed type(s); stainless steel with 3-inch nominal diameter.
- C. Dial: Nonreflective aluminum with permanently etched scale markings and scales in deg F and deg C.
- D. Connector Type(s): Union joint, adjustable angle, with unified-inch screw threads.
- E. Connector Size: 1/2 inch, with ASME B1.1 screw threads.
- F. Stem: 0.25 or 0.375 inch in diameter; stainless steel.
- G. Window: Plain glass.
- H. Ring: Stainless steel.
- I. Element: Bimetal coil.

- J. Pointer: Dark-colored metal.
- K. Accuracy: Plus or minus 1 percent of scale range.

2.02 LIQUID-IN-GLASS THERMOMETERS

A. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:

1. Standard: ASME B40.200.
2. Case: Cast aluminum; **7-inch** nominal size unless otherwise indicated.
3. Case Form: Adjustable angle unless otherwise indicated.
4. Tube: Glass with magnifying lens and blue or red organic liquid.
5. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F and deg C.
6. Window: Glass.
7. Stem: Aluminum and of length to suit installation.
 - a. Design for Thermowell Installation: Bare stem.
8. Connector: **1-1/4 inches (32 mm)**, with ASME B1.1 screw threads.
9. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

B. Plastic-Case, Industrial-Style, Liquid-in-Glass Thermometers:

1. Standard: ASME B40.200.
2. Case: Plastic; **7-inch** nominal size unless otherwise indicated.
3. Case Form: Adjustable angle unless otherwise indicated.
4. Tube: Glass with magnifying lens and blue or red organic liquid.
5. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F and deg C.
6. Window: Glass.
7. Stem: Aluminum, brass, or stainless steel and of length to suit installation.
 - a. Design for Thermowell Installation: Bare stem.
8. Connector: **1-1/4 inches**, with ASME B1.1 screw threads.
9. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

2.03 THERMOWELLS

A. Thermowells:

1. Standard: ASME B40.200.
2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
3. Material for Use with Copper Tubing: CNR or CUNI.
4. Material for Use with Steel Piping: CRES or CSA.
5. Type: Stepped shank unless straight or tapered shank is indicated.
6. External Threads: **NPS 1/2, NPS 3/4, or NPS 1**, ASME B1.20.1 pipe threads.
7. Internal Threads: **1/2, 3/4, and 1 inch** with ASME B1.1 screw threads.
8. Bore: Diameter required to match thermometer bulb or stem.

9. Insertion Length: Length required to match thermometer bulb or stem.
10. Lagging Extension: Include on thermowells for insulated piping and tubing.
11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

B. Heat-Transfer Medium: Mixture of graphite and glycerin.

2.04 PRESSURE GAGES

A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:

1. Standard: ASME B40.100.
2. Case: Liquid-filled or Sealed; cast aluminum or drawn steel; 4-1/2-inch nominal diameter.
3. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
4. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
5. Movement: Mechanical, with link to pressure element and connection to pointer.
6. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi and kPa.
7. Pointer: Dark-colored metal.
8. Window: Glass.
9. Ring: Stainless steel.
10. Accuracy: Grade B, plus or minus 2 percent of middle half of scale range.

2.05 GAGE ATTACHMENTS

- A. Snubbers: ASME B40.100, brass; with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and piston-type surge-dampening device. Include extension for use on insulated piping.
- B. Valves: brass ball or stainless-steel needle, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install thermowells with socket extending a minimum of 2 inches into fluid or to center of pipe as applicable and in vertical position in piping tees.
- B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.
- C. Install thermowells with extension on insulated piping.
- D. Fill thermowells with heat-transfer medium.

- E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.
- F. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.
- G. Install valve and snubber in piping for each pressure gage for fluids.
- H. Install thermometers in the following locations:
 - 1. Inlet and outlet of each water heater.
- I. Install pressure gages in the following locations:
 - 1. Building water service entrance into building.
- J. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.
- K. Adjust faces of meters and gages to proper angle for best visibility.

3.02 THERMOMETER SCHEDULE

- A. Thermometers at inlet and outlet of each domestic water heater shall be one of the following:
 - 1. Liquid-filled or Sealed, bimetallic-actuated type.
 - 2. Industrial-style, liquid-in-glass type.
- B. Thermometer stems shall be of length to match thermowell insertion length.

3.03 THERMOMETER SCALE-RANGE SCHEDULE

- A. Scale Range for Domestic Cold-Water Piping: 0 to 150 deg F and minus 20 to plus 70 deg C.
- B. Scale Range for Domestic Hot-Water Piping: 0 to 250 deg F and 0 to 150 deg C.

3.04 PRESSURE-GAGE SCHEDULE

- A. Pressure gages at discharge of each water service into building shall be the following:
 - 1. Liquid-filled or Sealed direct-mounted, metal case.

3.05 PRESSURE-GAGE SCALE-RANGE SCHEDULE

- A. Scale Range for Water Service Piping: 0 to 100 psi and 0 to 600 kPa.

END OF SECTION 22 05 19

SECTION 22 05 23**GENERAL-DUTY VALVES FOR PLUMBING PIPING****PART 1 - GENERAL****1.01 SUMMARY****A. Section Includes:**

1. Brass ball valves.
2. Bronze ball valves.
3. Iron, single-flange butterfly valves.
4. Bronze swing check valves.
5. Iron swing check valves.
6. Iron swing check valves with closure control.
7. Bronze globe valves.
8. Iron globe valves.
9. Chainwheels.

1.02 SUBMITTALS

- A. Product Data: For each type of valve indicated.

1.03 QUALITY ASSURANCE

- A. ASME Compliance: ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
- B. NSF Compliance: NSF 61 for valve materials for potable-water service.

PART 2 - PRODUCTS**2.01 GENERAL REQUIREMENTS FOR VALVES**

- A. Refer to valve schedule articles for applications of valves.
- B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- C. Valve Sizes: Same as upstream piping unless otherwise indicated.
- D. Valve Actuator Types:

1. Gear Actuator: For quarter-turn valves **NPS 8 (DN 200)** and larger.
 2. Handwheel: For valves other than quarter-turn types.
 3. Handlever: For quarter-turn valves **NPS 6 (DN 150)** and smaller.
 4. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator; of size and with chain for mounting height, as indicated in the "Valve Installation" Article.
- E. Valves in Insulated Piping: With **2-inch (50-mm)** stem extensions and the following features:
1. Gate Valves: With rising stem.
 2. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
 3. Butterfly Valves: With extended neck.
- F. Valve-End Connections:
1. Flanged: With flanges according to ASME B16.1 for iron valves.
 2. Solder Joint: With sockets according to ASME B16.18.
 3. Threaded: With threads according to ASME B1.20.1.
- 2.02 BRASS BALL VALVES
- A. Two-Piece, Full-Port, Brass Ball Valves with Brass Trim:
1. Description:
 - a. Standard: MSS SP-110.
 - b. SWP Rating: **150 psig (1035 kPa)**.
 - c. CWP Rating: **600 psig (4140 kPa)**.
 - d. Body Design: Two piece.
 - e. Body Material: Forged brass.
 - f. Ends: Threaded.
 - g. Seats: PTFE or TFE.
 - h. Stem: Brass.
 - i. Ball: Chrome-plated brass.
 - j. Port: Full.
- B. Two-Piece, Regular-Port, Brass Ball Valves with Brass Trim:
1. Description:
 - a. Standard: MSS SP-110.
 - b. SWP Rating: **150 psig (1035 kPa)**.
 - c. CWP Rating: **600 psig (4140 kPa)**.
 - d. Body Design: Two piece.
 - e. Body Material: Forged brass.
 - f. Ends: Threaded.

- g. Seats: PTFE or TFE.
- h. Stem: Brass.
- i. Ball: Chrome-plated brass.
- j. Port: Regular.

2.03 BRONZE BALL VALVES

A. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim:

1. Description:

- a. Standard: MSS SP-110.
- b. SWP Rating: 150 psig (1035 kPa).
- c. CWP Rating: 600 psig (4140 kPa).
- d. Body Design: Two piece.
- e. Body Material: Bronze.
- f. Ends: Threaded.
- g. Seats: PTFE or TFE.
- h. Stem: Bronze.
- i. Ball: Chrome-plated brass.
- j. Port: Full.

B. Two-Piece, Regular-Port, Bronze Ball Valves with Bronze Trim:

1. Description:

- a. Standard: MSS SP-110.
- b. SWP Rating: 150 psig (1035 kPa).
- c. CWP Rating: 600 psig (4140 kPa).
- d. Body Design: Two piece.
- e. Body Material: Bronze.
- f. Ends: Threaded.
- g. Seats: PTFE or TFE.
- h. Stem: Bronze.
- i. Ball: Chrome-plated brass.
- j. Port: Regular.

2.04 IRON, SINGLE-FLANGE BUTTERFLY VALVES

A. 200 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Aluminum-Bronze Disc:

1. Description:

- a. Standard: MSS SP-67, Type I.
- b. CWP Rating: 200 psig (1380 kPa).
- c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
- d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
- e. Seat: EPDM.

- f. Stem: One- or two-piece stainless steel.
 - g. Disc: Aluminum bronze.
 - B. 200 CWP, Iron, Single-Flange Butterfly Valves with NBR Seat and Aluminum-Bronze Disc:
 - 1. Description:
 - a. Standard: MSS SP-67, Type I.
 - b. CWP Rating: 200 psig (1380 kPa).
 - c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
 - d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
 - e. Seat: NBR.
 - f. Stem: One- or two-piece stainless steel.
 - g. Disc: Aluminum bronze.
 - C. 200 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Ductile-Iron Disc:
 - 1. Description:
 - a. Standard: MSS SP-67, Type I.
 - b. CWP Rating: 200 psig (1380 kPa).
 - c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
 - d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
 - e. Seat: EPDM.
 - f. Stem: One- or two-piece stainless steel.
 - g. Disc: Nickel-plated ductile iron.
 - D. 200 CWP, Iron, Single-Flange Butterfly Valves with NBR Seat and Ductile-Iron Disc:
 - 1. Description:
 - a. Standard: MSS SP-67, Type I.
 - b. CWP Rating: 200 psig (1380 kPa).
 - c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
 - d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
 - e. Seat: NBR.
 - f. Stem: One- or two-piece stainless steel.
 - g. Disc: Nickel-plated ductile iron.
- 2.05 BRONZE SWING CHECK VALVES
- A. Class 125, Bronze Swing Check Valves with Bronze Disc:
 - 1. Description:
 - a. Standard: MSS SP-80, Type 3.
 - b. CWP Rating: 200 psig (1380 kPa).
 - c. Body Design: Horizontal flow.
 - d. Body Material: ASTM B 62, bronze.
 - e. Ends: Threaded.

f. Disc: Bronze.

B. Class 125, Bronze Swing Check Valves with Nonmetallic Disc:

1. Description:

- a. Standard: MSS SP-80, Type 4.
- b. CWP Rating: 200 psig (1380 kPa).
- c. Body Design: Horizontal flow.
- d. Body Material: ASTM B 62, bronze.
- e. Ends: Threaded.
- f. Disc: PTFE or TFE.

2.06 IRON SWING CHECK VALVES

A. Class 125, Iron Swing Check Valves with Metal Seats:

1. Description:

- a. Standard: MSS SP-71, Type I.
- b. CWP Rating: 200 psig (1380 kPa).
- c. Body Design: Clear or full waterway.
- d. Body Material: ASTM A 126, gray iron with bolted bonnet.
- e. Ends: Flanged.
- f. Trim: Bronze.
- g. Gasket: Asbestos free.

B. Class 125, Iron Swing Check Valves with Nonmetallic-to-Metal Seats:

1. Description:

- a. Standard: MSS SP-71, Type I.
- b. CWP Rating: 200 psig (1380 kPa).
- c. Body Design: Clear or full waterway.
- d. Body Material: ASTM A 126, gray iron with bolted bonnet.
- e. Ends: Flanged.
- f. Trim: Composition.
- g. Seat Ring: Bronze.
- h. Disc Holder: Bronze.
- i. Disc: PTFE or TFE.
- j. Gasket: Asbestos free.

2.07 IRON SWING CHECK VALVES WITH CLOSURE CONTROL

A. Class 125, Iron Swing Check Valves with Lever- and Spring-Closure Control:

1. Description:

- a. Standard: MSS SP-71, Type I.
- b. CWP Rating: 200 psig (1380 kPa).
- c. Body Design: Clear or full waterway.
- d. Body Material: ASTM A 126, gray iron with bolted bonnet.
- e. Ends: Flanged.

- f. Trim: Bronze.
 - g. Gasket: Asbestos free.
 - h. Closure Control: Factory-installed, exterior lever and spring.
- B. Class 125, Iron Swing Check Valves with Lever- and Weight-Closure Control:
- a. Standard: MSS SP-71, Type I.
 - b. CWP Rating: 200 psig (1380 kPa).
 - c. Body Design: Clear or full waterway.
 - d. Body Material: ASTM A 126, gray iron with bolted bonnet.
 - e. Ends: Flanged.
 - f. Trim: Bronze.
 - g. Gasket: Asbestos free.
 - h. Closure Control: Factory-installed, exterior lever and weight.

2.08 BRONZE GLOBE VALVES

- A. Class 125, Bronze Globe Valves with Bronze Disc:
- 1. Description:
 - a. Standard: MSS SP-80, Type 1.
 - b. CWP Rating: 200 psig (1380 kPa).
 - c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
 - d. Ends: Threaded or solder joint.
 - e. Stem and Disc: Bronze.
 - f. Packing: Asbestos free.
 - g. Handwheel: Malleable iron, bronze, or aluminum.
- B. Class 125, Bronze Globe Valves with Nonmetallic Disc:
- 1. Description:
 - a. Standard: MSS SP-80, Type 2.
 - b. CWP Rating: 200 psig (1380 kPa).
 - c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
 - d. Ends: Threaded or solder joint.
 - e. Stem: Bronze.
 - f. Disc: PTFE or TFE.
 - g. Packing: Asbestos free.
 - h. Handwheel: Malleable iron, bronze, or aluminum.

2.09 IRON GLOBE VALVES

- A. Class 125, Iron Globe Valves:
- 1. Description:
 - a. Standard: MSS SP-85, Type I.
 - b. CWP Rating: 200 psig (1380 kPa).
 - c. Body Material: ASTM A 126, gray iron with bolted bonnet.
 - d. Ends: Flanged.
 - e. Trim: Bronze.

- f. Packing and Gasket: Asbestos free.

2.10 CHAINWHEELS

- A. Description: Valve actuation assembly with sprocket rim, brackets, and chain.
 - 1. Brackets: Type, number, size, and fasteners required to mount actuator on valve.
 - 2. Attachment: For connection to butterfly valve stems.
 - 3. Sprocket Rim with Chain Guides: Ductile iron, of type and size required for valve. Include zinc coating.
 - 4. Chain: Hot-dip, galvanized steel, of size required to fit sprocket rim.

PART 3 - EXECUTION

3.01 VALVE INSTALLATION

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.
- E. Install chainwheels on operators for butterfly and globe valves **NPS 4 (DN 100)** and larger and more than **96 inches (2400 mm)** above floor. Extend chains to **60 inches (1520 mm)** above finished floor.
 - 1. Install swing check valves for proper direction of flow and in horizontal position with hinge pin level.

3.02 ADJUSTING

- A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.03 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valve applications are not indicated, use the following:
 - 1. Shutoff Service: Ball and butterfly valves. Gate valves are only allowed at water and fire service entrance per local water company standards as shown on details on drawings.
 - 2. Throttling Service: Globe, ball, or butterfly valves.

3. Pump-Discharge Check Valves:
 - a. **NPS 2 (DN 50)** and Smaller: Bronze swing check valves with bronze disc.
 - b. **NPS 2-1/2 (DN 65)** and Larger for Domestic Water: Iron swing check valves with lever and weight or with spring.
 - c. **NPS 2-1/2 (DN 65)** and Larger for Sanitary Waste and Storm Drainage: Iron swing check valves with lever and weight or spring.
 - B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP class or CWP ratings may be substituted.
 - C. Select valves, except wafer types, with the following end connections:
 1. For Copper Tubing, **NPS 2 (DN 50)** and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
 2. For Copper Tubing, **NPS 2-1/2 to NPS 4 (DN 65 to DN 100)**: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
 3. For Copper Tubing, **NPS 5 (DN 125)** and Larger: Flanged ends.
 4. For Steel Piping, **NPS 2 (DN 50)** and Smaller: Threaded ends.
 5. For Steel Piping, **NPS 2-1/2 to NPS 4 (DN 65 to DN 100)**: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
 6. For Steel Piping, **NPS 5 (DN 125)** and Larger: Flanged ends.
- 3.04 LOW-PRESSURE, COMPRESSED-AIR VALVE SCHEDULE (**150 PSIG (1035 kPa)** OR LESS)
- A. Pipe **NPS 2 (DN 50)** and Smaller:
 1. Bronze and Brass Valves: May be provided with solder-joint ends instead of threaded ends.
 2. Ball Valves: Two piece, full or regular port, brass or bronze.
 3. Bronze Swing Check Valves: Class 125, bronze disc.
 - B. Pipe **NPS 2-1/2 (DN 65)** and Larger:
 1. Iron Valves, **NPS 2-1/2 to NPS 4 (DN 65 to NPS 100)**: May be provided with threaded ends instead of flanged ends.
 2. Iron, Single-Flange Butterfly Valves: 200 CWP, NBR seat, aluminum-bronze or ductile-iron disc.
 3. Iron Swing Check Valves: Class 125, metal seats.
- 3.05 DOMESTIC, HOT- AND COLD-WATER VALVE SCHEDULE
- A. Pipe **NPS 2 (DN 50)** and Smaller:
 1. Bronze and Brass Valves: May be provided with solder-joint ends instead of threaded ends.
 2. Bronze Angle Valves: Class 125, bronze disc.
 3. Ball Valves: Two piece, full or regular port, brass or bronze with brass or bronze trim.

4. Bronze Swing Check Valves: Class 125, bronze disc.
5. Bronze Globe Valves: Class 125, bronze disc.

B. Pipe **NPS 2-1/2 (DN 65)** and Larger:

1. Iron Valves, **NPS 2-1/2 to NPS 4 (DN 65 to NPS 100)**: May be provided with threaded ends instead of flanged ends.
2. Iron, Single-Flange Butterfly Valves: 200 CWP, EPDM or NBR seat, aluminum-bronze or ductile-iron disc.
3. Iron Swing Check Valves: Class 125, metal seats.
4. Iron Swing Check Valves with Closure Control: Class 125, lever and weight.
5. Iron Globe Valves: Class 125.

3.06 SANITARY-WASTE VALVE SCHEDULE

A. Pipe **NPS 2 (DN 50)** and Smaller:

1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
2. Ball Valves: Two piece, full port, bronze with bronze trim.
3. Bronze Swing Check Valves: Class 125, bronze disc.
4. Bronze Globe Valves: Class 125, bronze disc.

B. Pipe **NPS 2-1/2 (DN 65)** and Larger:

1. Iron Valves, **NPS 2-1/2 to NPS 4 (DN 65 to NPS 100)**: May be provided with threaded ends instead of flanged ends.
2. Iron Swing Check Valves: Class 125, metal seats.
3. Iron Swing Check Valves with Closure Control: Class 125, lever and spring or weight\.
4. Iron Globe Valves: Class 125.

END OF SECTION 22 05 23

SECTION 22 05 29**HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT**

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Metal pipe hangers and supports.

1.02 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Welding certificates.

1.03 QUALITY ASSURANCE

- A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.01 METAL PIPE HANGERS AND SUPPORTS

- A. Carbon-Steel Pipe Hangers and Supports:
 - 1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
 - 2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
 - 3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
 - 4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
 - 5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
- B. Copper Pipe Hangers:
 - 1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
 - 2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel.

2.02 FASTENER SYSTEMS

- A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
- B. Mechanical-Expansion Anchors: Insert-wedge-type, stainless steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.03 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.
- B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
 - 1. Properties: Nonstaining, noncorrosive, and nongaseous.
 - 2. Design Mix: **5000-psi**, 28-day compressive strength.

PART 3 - EXECUTION

3.01 HANGER AND SUPPORT INSTALLATION

- A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
- B. Fastener System Installation:
 - 1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than **4 inches** thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
 - 2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- C. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- D. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- E. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

- F. Install lateral bracing with pipe hangers and supports to prevent swaying.
- G. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
- H. Insulated Piping:
 - 1. Attach clamps and spacers to piping.
 - a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
 - b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
 - c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
 - 2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe **NPS 4** and larger if pipe is installed on rollers.
 - 3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe **NPS 4** and larger if pipe is installed on rollers.
 - 4. Shield Dimensions for Pipe: Not less than the following:
 - a. **NPS 1/4 to NPS 3-1/2: 12 inches** long and **0.048 inch** thick.
 - b. **NPS 4: 12 inches** long and **0.06 inch** thick.
 - c. **NPS 5 and NPS 6: 18 inches** long and **0.06 inch** thick.

3.02 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make bearing surface smooth.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.03 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.04 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to **1-1/2 inches**.

3.05 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 1. Apply paint by brush or spray to provide a minimum dry film thickness of **2.0 mils**.
- B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Painting Section
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.06 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use carbon-steel pipe hangers and supports and attachments for general service applications.
- F. Use stainless-steel pipe hangers and stainless-steel or corrosion-resistant attachments for hostile environment applications.

- G. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.
- H. Use padded hangers for piping that is subject to scratching.
- I. Use thermal-hanger shield inserts for insulated piping and tubing.
- J. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes **NPS 1/2 to NPS 30**.
 2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to **1050 deg F**, pipes **NPS 4 to NPS 24**, requiring up to **4 inches** of insulation.
 3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes **NPS 3/4 to NPS 36**, requiring clamp flexibility and up to **4 inches** of insulation.
 4. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes **NPS 1/2 to NPS 8**.
 5. U-Bolts (MSS Type 24): For support of heavy pipes **NPS 1/2 to NPS 30**.
 6. Pipe Saddle Supports (MSS Type 36): For support of pipes **NPS 4 to NPS 36**, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
 7. Pipe Stanchion Saddles (MSS Type 37): For support of pipes **NPS 4 to NPS 36**, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
 8. Single-Pipe Rolls (MSS Type 41): For suspension of pipes **NPS 1 to NPS 30**, from two rods if longitudinal movement caused by expansion and contraction might occur.
 9. Complete Pipe Rolls (MSS Type 44): For support of pipes **NPS 2 to NPS 42** if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
- K. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers **NPS 3/4 to NPS 24**.
 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers **NPS 3/4 to NPS 24** if longer ends are required for riser clamps.
- L. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to **6 inches** for heavy loads.
 2. Steel Clevises (MSS Type 14): For **120 to 450 deg F** piping installations.
- M. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joint construction, to attach to top flange of structural shape.
 3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 6. C-Clamps (MSS Type 23): For structural shapes.
 7. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lb.
 - b. Medium (MSS Type 32): 1500 lb.
 - c. Heavy (MSS Type 33): 3000 lb.
 8. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
 9. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
- N. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- O. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- P. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.
- Q. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

END OF SECTION 22 05 29

SECTION 22 05 53**IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT****PART 1 - GENERAL****1.01 SUMMARY**

- A. Section Includes:
1. Equipment labels.
 2. Warning signs and labels.
 3. Pipe labels.

1.02 ACTION SUBMITTAL

- A. Product Data: For each type of product indicated.

PART 2 - PRODUCTS**2.01 EQUIPMENT LABELS**

- A. Metal Labels for Equipment:
1. Material and Thickness: Brass, 0.032-inch (0.8-mm), Stainless steel, 0.025-inch (0.64-mm), Aluminum, 0.032-inch (0.8-mm) or anodized aluminum, 0.032-inch (0.8-mm) minimum thickness, and having predrilled or stamped holes for attachment hardware.
 2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
 3. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 4. Fasteners: Stainless-steel rivets or self-tapping screws.
 5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.
- C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch (A4) bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the

Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.02 WARNING SIGNS AND LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, **1/16 inch (1.6 mm)** thick, and having predrilled holes for attachment hardware.
- B. Letter Color: Black.
- C. Background Color: Yellow.
- D. Maximum Temperature: Able to withstand temperatures up to **160 deg F (71 deg C)**.
- E. Minimum Label Size: Length and width vary for required label content, but not less than **2-1/2 by 3/4 inch (64 by 19 mm)**.
- F. Minimum Letter Size: **1/4 inch (6.4 mm)** for name of units if viewing distance is less than **24 inches (600 mm)**, **1/2 inch (13 mm)** for viewing distances up to **72 inches (1830 mm)**, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- G. Fasteners: Stainless-steel rivets or self-tapping screws.
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- I. Label Content: Include caution and warning information, plus emergency notification instructions.

2.03 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
- C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
 - 1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
 - 2. Lettering Size: At least **1-1/2 inches (38 mm)** high.

PART 3 - EXECUTION**3.01 PREPARATION**

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.02 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

3.03 PIPE LABEL INSTALLATION

- A. Piping Color-Coding: Painting of piping is specified in Division 9.
- B. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 - 1. Near each valve and control device.
 - 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 - 3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
 - 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 - 5. Near major equipment items and other points of origination and termination.
 - 6. Spaced at maximum intervals of **50 feet (15 m)** along each run. Reduce intervals to **25 feet (7.6 m)** in areas of congested piping and equipment.
- C. Pipe Label Color Schedule:
 - 1. Compressed-Air Piping: Painting and labeling Compressed Air Pipe is shown on the Equipment Drawings.
 - 2. Domestic Water Piping:
 - a. Background Color: White.
 - b. Letter Color: Green.
 - 3. Sanitary Waste and Storm Drainage Piping:
 - a. Background Color: White.
 - b. Letter Color: Black.

END OF SECTION 22 05 53

SECTION 22 07 19**PLUMBING PIPING INSULATION****PART 1 - GENERAL****1.01 SUMMARY**

- A. Section includes insulating the following plumbing piping services:
1. Domestic hot-water piping.
 2. Domestic recirculating hot-water piping.
 3. Sanitary waste piping exposed to freezing conditions.
 4. Storm-water piping exposed to freezing conditions.
 5. Roof drains and rainwater leaders.
 6. Supplies and drains for handicap-accessible lavatories and sinks.

1.02 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. LEED Submittals:
1. Product Data for Credit IEQ 4.1: For adhesives and sealants, documentation including printed statement of VOC content and chemical components.
 2. Laboratory Test Reports for Credit IEQ 4: For adhesives and sealants, documentation indicating that product complies with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
 2. Detail attachment and covering of heat tracing inside insulation.
 3. Detail insulation application at pipe expansion joints for each type of insulation.
 4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
 5. Detail removable insulation at piping specialties, equipment connections, and access panels.
 6. Detail application of field-applied jackets.
 7. Detail application at linkages of control devices.
- D. Field quality-control reports.

1.03 QUALITY ASSURANCE

- A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84 by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.
- B. Comply with the following applicable standards and other requirements specified for miscellaneous components:
 - 1. Supply and Drain Protective Shielding Guards: ICC A117.1.

PART 2 - PRODUCTS

2.01 INSULATION MATERIALS

- A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 - 1. Special-Shaped Insulation: ASTM C 552, Type III.
 - 2. Preformed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class 1.
 - 3. Preformed Pipe Insulation with Factory-Applied ASJ: Comply with ASTM C 552, Type II, Class 2.
 - 4. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.

- G. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.
- H. Mineral-Fiber, Preformed Pipe Insulation:
 - 1. Type I, 850 Deg F (454 Deg C) Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.02 INSULATING CEMENTS

- A. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.

2.03 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.
- B. Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200 deg F (minus 73 to plus 93 deg C).
 - 1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 2. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- C. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
 - 1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 2. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- D. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
 - 1. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 2. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

- E. ASJ Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
 - 1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 2. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

- F. PVC Jacket Adhesive: Compatible with PVC jacket.
 - 1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 2. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.04 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
 - 1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

- B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.
 - 1. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, **0.013 perm (0.009 metric perm)** at **43-mil (1.09-mm)** dry film thickness.
 - 2. Service Temperature Range: **Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C)**.
 - 3. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
 - 4. Color: White.

- C. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.
 - 1. Water-Vapor Permeance: ASTM F 1249, **1.8 perms (1.2 metric perms)** at **0.0625-inch (1.6-mm)** dry film thickness.
 - 2. Service Temperature Range: **Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C)**.
 - 3. Solids Content: 60 percent by volume and 66 percent by weight.
 - 4. Color: White.

2.05 SEALANTS

- A. Joint Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Permanently flexible, elastomeric sealant.
3. Service Temperature Range: Minus 100 to plus 300 deg F (Minus 73 to plus 149 deg C).
4. Color: White or gray.
5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
6. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. FSK and Metal Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
4. Color: Aluminum.
5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
6. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

- a.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
5. Color: White.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.06 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

2.07 FIELD-APPLIED FABRIC-REINFORCING MESH

- A. Woven Polyester Fabric: Approximately **1 oz./sq. yd. (34 g/sq. m)** with a thread count of **10 strands by 10 strands/sq. in. (4 strands by 4 strands/sq. mm)**, in a Leno weave, for pipe.

2.08 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
 - 1. Adhesive: As recommended by jacket material manufacturer.
 - 2. Color: White.
 - 3. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
 - a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.
- C. Underground Direct-Buried Jacket: **125-mil- (3.2-mm-)** thick vapor barrier and waterproofing membrane consisting of a rubberized bituminous resin reinforced with a woven-glass fiber or polyester scrim and laminated aluminum foil.

2.09 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
 - 1. Width: **3 inches (75 mm)**.
 - 2. Thickness: **11.5 mils (0.29 mm)**.
 - 3. Adhesion: **90 ounces force/inch (1.0 N/mm)** in width.
 - 4. Elongation: 2 percent.
 - 5. Tensile Strength: **40 lbf/inch (7.2 N/mm)** in width.
 - 6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
 - 1. Width: **2 inches (50 mm)**.
 - 2. Thickness: **6 mils (0.15 mm)**.
 - 3. Adhesion: **64 ounces force/inch (0.7 N/mm)** in width.
 - 4. Elongation: 500 percent.
 - 5. Tensile Strength: **18 lbf/inch (3.3 N/mm)** in width.

2.10 SECUREMENTS

- A. Aluminum Bands: **ASTM B 209 (ASTM B 209M)**, Alloy 3003, 3005, 3105, or 5005; Temper H-14, **0.020 inch (0.51 mm)** thick, **3/4 inch (19 mm)** wide with wing seal or closed seal.
- B. Staples: Outward-clinching insulation staples, nominal **3/4-inch- (19-mm-)** wide, stainless steel or Monel.
- C. Wire: **0.080-inch (2.0-mm)** nickel-copper alloy, **0.062-inch (1.6-mm)** soft-annealed, stainless steel or **0.062-inch (1.6-mm)** soft-annealed, galvanized steel.

2.11 PROTECTIVE SHIELDING GUARDS

- A. Protective Shielding Pipe Covers:
 - 1. Description: Manufactured plastic wraps for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.
- B. Protective Shielding Piping Enclosures:
 - 1. Description: Manufactured plastic enclosure for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with ADA requirements.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.02 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.

- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
 - 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Install insulation with factory-applied jackets as follows:
 - 1. Draw jacket tight and smooth.
 - 2. Cover circumferential joints with **3-inch- (75-mm-)** wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced **4 inches (100 mm)** o.c.
 - 3. Overlap jacket longitudinal seams at least **1-1/2 inches (38 mm)**. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at [**2 inches (50 mm)**] [**4 inches (100 mm)**] o.c.
 - a. For below-ambient services, apply vapor-barrier mastic over staples.
 - 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
 - 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

- M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least **4 inches (100 mm)** beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- P. For above-ambient services, do not install insulation to the following:
 - 1. Vibration-control devices.
 - 2. Testing agency labels and stamps.
 - 3. Nameplates and data plates.
 - 4. Cleanouts.

3.03 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
 - 1. Seal penetrations with flashing sealant.
 - 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 - 3. Extend jacket of outdoor insulation outside roof flashing at least **2 inches (50 mm)** below top of roof flashing.
 - 4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.
- C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
 - 1. Seal penetrations with flashing sealant.
 - 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 - 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least **2 inches (50 mm)**.
 - 4. Seal jacket to wall flashing with flashing sealant.
- D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

- E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
 - 1. Comply with requirements in Section 07 84 13 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

- F. Insulation Installation at Floor Penetrations:
 - 1. Pipe: Install insulation continuously through floor penetrations.
 - 2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 07 84 13 "Penetration Firestopping."

3.04 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
 - 1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
 - 2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
 - 3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
 - 4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
 - 5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
 - 6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
 - 7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a

- breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
 9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.
- C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
 2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
 3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
 4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least **2 inches (50 mm)** over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
 5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.05 INSTALLATION OF CELLULAR-GLASS INSULATION

- A. Insulation Installation on Straight Pipes and Tubes:
1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
 2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
 3. For insulation with factory-applied jackets on above-ambient services, secure laps with outward clinched staples at **6 inches (150 mm)** o.c.
 4. For insulation with factory-applied jackets on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as

recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as pipe insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least **1 inch (25 mm)**, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of cellular-glass insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

3.06 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.

2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.07 INSTALLATION OF MINERAL-FIBER PREFORMED PIPE INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward clinched staples at **6 inches (150 mm)** o.c.
4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least **1 inch (25 mm)**, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

- D. Insulation Installation on Valves and Pipe Specialties:
1. Install preformed sections of same material as straight segments of pipe insulation when available.
 2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
 3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 4. Install insulation to flanges as specified for flange insulation application.

3.08 FIELD-APPLIED JACKET INSTALLATION

- A. Where PVC jackets are indicated, install with **1-inch (25-mm)** overlap at longitudinal seams and end joints. Seal with manufacturer's recommended adhesive.
1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

3.09 FINISHES

- A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 09 91 13 "Exterior Painting" and Section 09 91 23 "Interior Painting."
1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
 - a. Finish Coat Material: Interior, flat, latex-emulsion size.
- B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
- C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
- D. Do not field paint aluminum or stainless-steel jackets.

3.10 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
1. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to 3 locations of straight pipe, 3 locations of threaded fittings, 3 locations of welded fittings, 2 locations of threaded strainers, 2 locations of welded strainers, 3 locations of threaded valves, and 3 locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

- C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.11 PIPING INSULATION SCHEDULE, GENERAL

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
- B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
 - 1. Drainage piping located in crawl spaces.
 - 2. Underground piping.
 - 3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.12 INDOOR PIPING INSULATION SCHEDULE

- A. Domestic Hot and Recirculated Hot Water: Insulation shall be one of the following:
 - 1. Flexible Elastomeric: 1 inch (25 mm) thick.
 - 2. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch (25 mm) thick.
- B. Stormwater and Overflow: Insulation shall be one of the following:
 - 1. Flexible Elastomeric: 1 inch (25 mm) thick.
 - 2. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch (25 mm) thick.
- C. Roof Drain and Overflow Drain Bodies: Insulation shall be one of the following:
 - 1. Flexible Elastomeric: 1 inch (25 mm) thick.
 - 2. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch (25 mm) thick.
- D. Exposed Sanitary Drains, Domestic Water, Domestic Hot Water, and Stops for Plumbing Fixtures for People with Disabilities: Insulation shall be one of the following:
 - 1. Flexible Elastomeric: 3/4 inch (19 mm) thick.
 - 2. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch (25 mm) thick.

3.13 INDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Domestic Water Piping, Exposed in Wash Bay and Wash equipment room:
 - 1. PVC: 20 mils (0.5 mm) thick.

3.14 UNDERGROUND, FIELD-INSTALLED INSULATION JACKET

- A. For underground direct-buried piping applications, install underground direct-buried jacket over insulation material.

END OF SECTION 22 07 19

SECTION 22 11 16
DOMESTIC WATER PIPING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes under-building-slab and aboveground domestic water pipes, tubes, and fittings inside buildings.

1.02 SUBMITTALS

- A. Product Data: For transition fittings and dielectric fittings.
- B. System purging and disinfecting activities report.
- C. Field quality-control reports.

PART 2 - PRODUCTS

2.01 PIPING MATERIALS

- A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.
- B. Potable-water piping and components shall comply with NSF 14 and NSF 61. Plastic piping components shall be marked with "NSF-pw."

2.02 COPPER TUBE AND FITTINGS

- A. Hard Copper Tube: **ASTM B 88, Type L** or **ASTM B 88, Type M** water tube, drawn temper.
- B. Soft Copper Tube: **ASTM B 88, Type K** and **ASTM B 88, Type L** water tube, annealed temper.
- C. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.
- D. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
- E. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.

F. Copper Unions:

1. MSS SP-123.
2. Cast-copper-alloy, hexagonal-stock body.
3. Ball-and-socket, metal-to-metal seating surfaces.
4. Solder-joint or threaded ends.

G. Copper Pressure-Seal-Joint Fittings:

1. Fittings for **NPS 2** and Smaller: Wrought-copper fitting with EPDM-rubber, O-ring seal in each end.
2. Fittings for **NPS 2-1/2 to NPS 4**: Cast-bronze or wrought-copper fitting with EPDM-rubber, O-ring seal in each end.

H. Copper Push-on-Joint Fittings:

1. Cast-copper fitting complying with ASME B16.18 or wrought-copper fitting complying with ASME B 16.22.
2. Stainless-steel teeth and EPDM-rubber, O-ring seal in each end instead of solder-joint ends.

2.03 DUCTILE-IRON PIPE AND FITTINGS

A. Mechanical-Joint, Ductile-Iron Pipe:

1. AWWA C151/A21.51, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.
2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

B. Standard-Pattern, Mechanical-Joint Fittings:

1. AWWA C110/A21.10, ductile or gray iron.
2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

C. Compact-Pattern, Mechanical-Joint Fittings:

1. AWWA C153/A21.53, ductile iron.
2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

2.04 GALVANIZED-STEEL PIPE AND FITTINGS

A. Galvanized-Steel Pipe:

1. ASTM A 53/A 53M, Type E, Grade B Standard Weight.
2. Include ends matching joining method.

- B. Galvanized-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106/A 106M, Standard Weight, seamless steel pipe with threaded ends.
- C. Galvanized, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.
- D. Malleable-Iron Unions:
 - 1. ASME B16.39, Class 150.
 - 2. Hexagonal-stock body.
 - 3. Ball-and-socket, metal-to-metal, bronze seating surface.
 - 4. Threaded ends.
- E. Flanges: ASME B16.1, Class 125, cast iron.

2.05 CPVC PIPING

- A. CPVC Pipe: ASTM F 441/F 441M, Schedule 40 and Schedule 80.
 - 1. CPVC Socket Fittings: ASTM F 438 for Schedule 40 and ASTM F 439 for Schedule 80.
 - 2. CPVC Threaded Fittings: ASTM F 437, Schedule 80.
- B. CPVC Piping System: ASTM D 2846/D 2846M, SDR 11, pipe and socket fittings.

2.06 PVC PIPE AND FITTINGS

- A. PVC Pipe: ASTM D 1785, Schedule 40 and Schedule 80.
- B. PVC Socket Fittings: ASTM D 2466 for Schedule 40 and ASTM D 2467 for Schedule 80.
- C. PVC Schedule 80 Threaded Fittings: ASTM D 2464.

2.07 PIPING JOINING MATERIALS

- A. Pipe-Flange Gasket Materials:
 - 1. AWWA C110/A21.10, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free unless otherwise indicated.
 - 2. Full-face or ring type unless otherwise indicated.
- B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
- C. Solder Filler Metals: ASTM B 32, lead-free alloys.
- D. Flux: ASTM B 813, water flushable.

- E. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.
- F. Solvent Cements for Joining CPVC Piping and Tubing: ASTM F 493.
 - 1. CPVC solvent cement shall have a VOC content of 490 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 2. Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 3. Solvent cement and adhesive primer shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- G. Solvent Cements for Joining PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
 - 1. PVC solvent cement shall have a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 2. Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 3. Solvent cement and adhesive primer shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- H. Plastic, Pipe-Flange Gaskets, Bolts, and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.

2.08 TRANSITION FITTINGS

- A. General Requirements:
 - 1. Same size as pipes to be joined.
 - 2. Pressure rating at least equal to pipes to be joined.
 - 3. End connections compatible with pipes to be joined.
- B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
- C. Plastic-to-Metal Transition Fittings:
 - 1. Description:
 - a. CPVC or PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions.
 - b. One end with threaded brass insert and one solvent-cement-socket or threaded end.
- D. Plastic-to-Metal Transition Unions:
 - 1. Description:

- a. CPVC or PVC four-part union.
- b. Brass or stainless-steel threaded end.
- c. Solvent-cement-joint or threaded plastic end.
- d. Rubber O-ring.
- e. Union nut.

2.09 DIELECTRIC FITTINGS

- A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
- B. Dielectric Unions:
 1. Standard: ASSE 1079.
 2. Pressure Rating: 125 psig minimum at 180 deg F.
 3. End Connections: Solder-joint copper alloy and threaded ferrous.
- C. Dielectric Flanges:
 1. Standard: ASSE 1079.
 2. Factory-fabricated, bolted, companion-flange assembly.
 3. Pressure Rating: 125 psig minimum at 180 deg F.
 4. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
- D. Dielectric-Flange Insulating Kits:
 1. Nonconducting materials for field assembly of companion flanges.
 2. Pressure Rating: 150 psig.
 3. Gasket: Neoprene or phenolic.
 4. Bolt Sleeves: Phenolic or polyethylene.
 5. Washers: Phenolic with steel backing washers.
- E. Dielectric Nipples:
 1. Standard: IAPMO PS 66.
 2. Electroplated steel nipple complying with ASTM F 1545.
 3. Pressure Rating and Temperature: 300 psig at 225 deg F.
 4. End Connections: Male threaded or grooved.
 5. Lining: Inert and noncorrosive, propylene.

PART 3 - EXECUTION

3.01 EARTHWORK

- A. Comply with requirements in Section 31 20 00 "Earth Moving" for excavating, trenching, and backfilling.

3.02 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.
- B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."
- C. Install ductile-iron piping under building slab with restrained joints according to AWWA C600 and AWWA M41.
- D. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve inside the building at each domestic water-service entrance. Comply with requirements for pressure gages in Section 22 05 19 "Meters and Gages for Plumbing Piping" and with requirements for drain valves and strainers in Section 22 11 19 "Domestic Water Piping Specialties."
- E. Install shutoff valve immediately upstream of each dielectric fitting.
- F. Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements for pressure-reducing valves in Section 22 11 19 "Domestic Water Piping Specialties."
- G. Install domestic water piping level without pitch and plumb.
- H. Rough-in domestic water piping for water-meter installation according to utility company's requirements.
- I. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- J. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- K. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.
- L. Install piping to permit valve servicing.
- M. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.
- N. Install piping free of sags and bends.
- O. Install fittings for changes in direction and branch connections.
- P. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

- Q. Install pressure gages per requirements for pressure gages in Section 22 05 19 "Meters and Gages for Plumbing Piping."
- R. Install sleeves for piping penetrations of walls, ceilings, and floor per requirements for sleeves specified in Section 22 05 17 "Sleeves and Sleeve Seals for Plumbing Piping."
- S. Install sleeve seals for piping penetrations of concrete walls and slabs per requirements for sleeve seals specified in Section 22 05 17 "Sleeves and Sleeve Seals for Plumbing Piping."
- T. Install escutcheons for piping penetrations of walls, ceilings, and floors per requirements for escutcheons specified in Section 22 05 18 "Escutcheons for Plumbing Piping."

3.03 JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- D. Brazed Joints for Copper Tubing: Comply with CDA's "Copper Tube Handbook," "Braze Joints" chapter.
- E. Soldered Joints for Copper Tubing: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."
- F. Pressure-Sealed Joints for Copper Tubing: Join copper tube and pressure-seal fittings with tools recommended by fitting manufacturer.
- G. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.
- H. Joint Construction for Solvent-Cemented Plastic Piping: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 - 1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements. Apply primer.
 - 2. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
 - 3. PVC Piping: Join according to ASTM D 2855.

- I. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

3.04 TRANSITION FITTING INSTALLATION

- A. Install transition couplings at joints of dissimilar piping.
- B. Transition Fittings in Underground Domestic Water Piping:
 1. Fittings for **NPS 1-1/2** and Smaller: Fitting-type coupling.
 2. Fittings for **NPS 2** and Larger: Sleeve-type coupling.
- C. Transition Fittings in Aboveground Domestic Water Piping **NPS 2** and Smaller: Plastic-to-metal transition fittings or unions.

3.05 DIELECTRIC FITTING INSTALLATION

- A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
- B. Dielectric Fittings for **NPS 2** and Smaller: Use dielectric couplings, nipples or unions.
- C. Dielectric Fittings for **NPS 2-1/2 and larger**: Use dielectric flange or flange kits.

3.06 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements for seismic-restraint devices in Section 22 05 48 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- B. Comply with requirements for pipe hanger, support products, and installation in Section 22 05 29 "Hangers and Supports for Plumbing Piping and Equipment."
 1. Vertical Piping: MSS Type 8 or 42, clamps.
 2. Individual, Straight, Horizontal Piping Runs:
 - a. **100 Feet** and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than **100 Feet** MSS Type 43, adjustable roller hangers.
 - c. Longer Than **100 Feet**) if Indicated: MSS Type 49, spring cushion rolls.
 3. Multiple, Straight, Horizontal Piping Runs **100 Feet** or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 4. Base of Vertical Piping: MSS Type 52, spring hangers.
- C. Support vertical piping and tubing at base and at each floor.
- D. Rod diameter may be reduced one size for double-rod hangers, to a minimum of **3/8 inch**.
- E. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
 2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
 3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
- F. Install supports for vertical copper tubing every 10 feet.
- G. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 2-1/2: 11 feet with 1/2-inch rod.
 2. NPS 3 and NPS 3-1/2: 2 feet with 1/2-inch rod.
 3. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
 4. NPS 6: 12 feet with 3/4-inch rod.
 5. NPS 8 to NPS 12: 12 feet with 7/8-inch rod.
- H. Install supports for vertical steel piping every 15 feet.
- I. Install vinyl-coated hangers for CPVC piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1 and Smaller: 36 inches with 3/8-inch rod.
 2. NPS 1-1/4 to NPS 2: 48 inches with 3/8-inch rod.
 3. NPS 2-1/2 to NPS 3-1/2: 48 inches with 1/2-inch rod.
 4. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
 5. NPS 6: 48 inches with 3/4-inch rod.
 6. NPS 8: 48 inches with 7/8-inch rod.
- J. Install supports for vertical CPVC piping every 60 inches for NPS 1) and smaller, and every 72 inches for NPS 1-1/4 and larger.
- K. Install vinyl-coated hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 2 and Smaller: 48 inches with 3/8-inch rod.
 2. NPS 2-1/2 to NPS 3-1/2: 48 inches with 1/2-inch rod.
 3. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
 4. NPS 6: 48 inches with 3/4-inch rod.
 5. NPS 8: 48 inches with 7/8-inch rod.
- L. Install supports for vertical PVC piping every 48 inches.
- M. Support piping and tubing not listed in this article according to MSS SP-69 and manufacturer's written instructions.
- 3.07 CONNECTIONS
- A. Drawings indicate general arrangement of piping, fittings, and specialties.

- B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.
- C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.
- D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:
 - 1. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
 - 2. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.
 - 3. Equipment: Cold- and hot-water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for **NPS 2-1/2** and larger.

3.08 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Piping Inspections:
 - a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
 - b. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
 - 1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after roughing in and before setting fixtures.
 - 2) Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.
 - c. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
 - d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
 - 2. Piping Tests:
 - a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
 - b. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
 - c. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.

- d. Cap and subject piping to static water pressure of 50 psig) above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
 - e. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
 - f. Prepare reports for tests and for corrective action required.
- B. Domestic water piping will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

3.09 ADJUSTING

- A. Perform the following adjustments before operation:
1. Close drain valves, hydrants, and hose bibbs.
 2. Open shutoff valves to fully open position.
 3. Open throttling valves to proper setting.
 4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
 - a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide hot-water flow in each branch.
 - b. Adjust calibrated balancing valves to flows indicated.
 5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
 6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
 7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
 8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.10 CLEANING

- A. Clean and disinfect potable domestic water piping as follows:
1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
 2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
 - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
 - b. Fill and isolate system according to either of the following:
 - 1) Fill system or part thereof with water/chlorine solution with at least 50 ppm (50 mg/L) of chlorine. Isolate with valves and allow to stand for 24 hours.

- 2) Fill system or part thereof with water/chlorine solution with at least 200 ppm (200 mg/L) of chlorine. Isolate and allow to stand for three hours.
 - c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
 - d. Repeat procedures if biological examination shows contamination.
 - e. Submit water samples in sterile bottles to authorities having jurisdiction.
- B. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.
- C. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.11 PIPING SCHEDULE

- A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
- B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.
- C. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.
- D. Under-building-slab, domestic water or building-service piping, NPS 3 and smaller, shall be one of the following:
1. Soft copper tube, ASTM B 88, Type K; wrought-copper, solder-joint fittings; and brazed or copper pressure-seal fittings; and pressure-sealed joints.
 2. PVC, Schedule 80; socket fittings; and solvent-cemented joints.
- E. Under-building-slab, domestic water or building-service piping, NPS 4 and larger, shall be one of the following:
1. Soft copper tube, ASTM B 88, Type K; wrought-copper, solder-joint fittings; and brazed joints.
 2. Plain-end, ductile-iron pipe; grooved-joint, ductile-iron-pipe appurtenances; and grooved joints.
 3. PVC, Schedule 40; socket fittings; and solvent-cemented joints.
- F. Aboveground domestic water piping, NPS 2 and smaller, shall be one of the following:
1. Hard copper tube, ASTM B 88, Type L; cast or wrought-copper, solder-joint fittings; and brazed or soldered joints.
 2. Hard copper tube, ASTM B 88, Type L or ASTM B 88, Type M; copper pressure-seal-joint fittings; and pressure-sealed joints.
 3. Hard copper tube, ASTM B 88, Type L or ASTM B 88, Type M; copper push-on-joint fittings; and push-on joints.

4. CPVC, Schedule 40; socket fittings; and solvent-cemented joints.
 5. PVC, Schedule 40; socket fittings; and solvent-cemented joints.
- G. Aboveground domestic water piping, **NPS 2-1/2 and larger**, shall be one of the following:
1. Galvanized-steel pipe and nipples; galvanized, gray-iron threaded fittings; and threaded joints.
 2. CPVC, Schedule 40; socket fittings; and solvent-cemented joints.
 3. PVC, Schedule 40; socket fittings; and solvent-cemented joints.

END OF SECTION 22 11 16

SECTION 22 11 19
DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
1. Vacuum breakers.
 2. Backflow preventers.
 3. Water pressure-reducing valves.
 4. Balancing valves.
 5. Temperature-actuated, water mixing valves.
 6. Strainers.
 7. Hose bibbs.
 8. Wall hydrants.
 9. Drain valves.
 10. Water-hammer arresters.

1.02 SUBMITTALS

- A. Product Data: For each type of product.
- B. Field quality-control reports.
- C. Operation and maintenance data.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS FOR PIPING SPECIALTIES

- A. Potable-water piping and components shall comply with NSF 61 and NSF 14. Mark "NSF-pw" on plastic piping components.

2.02 PERFORMANCE REQUIREMENTS

- A. Minimum Working Pressure for Domestic Water Piping Specialties: **125 psig** unless otherwise indicated.

2.03 VACUUM BREAKERS

- A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:

1. Standard: ASSE 1001.
2. Size: **NPS 1/4 to NPS 3**, as required to match connected piping.
3. Body: Bronze.
4. Inlet and Outlet Connections: Threaded.
5. Finish: Rough bronze.

B. Hose-Connection Vacuum Breakers:

1. Standard: ASSE 1011.
2. Body: Bronze, nonremovable, with manual drain.
3. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
4. Finish: Rough bronze.

2.04 BACKFLOW PREVENTERS

A. Reduced-Pressure-Principle Backflow Preventers:

1. Standard: ASSE 1013.
2. Operation: Continuous-pressure applications.
3. Pressure Loss: 12 PSIG maximum, through middle third of flow range.
4. Size: as shown on drawings.
5. Design Flow Rate: as shown on drawings.
6. Body: Bronze for **NPS 2** and smaller; steel with interior lining that complies with AWWA C550 or that is FDA approved. For **NPS 2-1/2** and larger stainless steel.
7. End Connections: Threaded for **NPS 2** and smaller; flanged for **NPS 2-1/2** and larger.
8. Configuration: Designed for horizontal, straight-through or vertical-inlet and outlet (if space is limited) flow.
9. Accessories:
 - a. Valves **NPS 2** and Smaller: Ball type with threaded ends on inlet and outlet.
 - b. Valves **NPS 2-1/2** and Larger: Outside-screw and yoke-gate type with flanged ends on inlet and outlet.
 - c. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.

B. Double-Check, Backflow-Prevention Assemblies:

1. Standard: ASSE 1015.
2. Operation: Continuous-pressure applications unless otherwise indicated.
3. Pressure Loss: **5 psig** maximum, through middle third of flow range.
4. Size: as shown on drawings.
5. Bronze for **NPS 2** and smaller; steel with interior lining that complies with AWWA C550 or that is FDA approved. For **NPS 2-1/2** and larger stainless steel. End Connections: Threaded for **NPS 2** and smaller; flanged for **NPS 2-1/2** and larger.
6. Configuration: Designed for horizontal, straight-through flow.
7. Accessories:
 - a. Valves **NPS 2** and Smaller: Ball type with threaded ends on inlet and outlet.

- b. Valves **NPS 2-1/2** and Larger: Outside-screw and yoke-gate type with flanged ends on inlet and outlet.

2.05 WATER PRESSURE-REDUCING VALVES

A. Water Regulators:

1. Standard: ASSE 1003.
2. Pressure Rating: Initial working pressure of **150 psig**.
3. Body: Bronze with chrome-plated finish for **NPS 2** and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved for **NPS 2-1/2 and NPS 3**.
4. Valves for Booster Heater Water Supply: Include integral bypass.
5. End Connections: Threaded for **NPS 2** and smaller; flanged for **NPS 2-1/2 and NPS 3**.

2.06 BALANCING VALVES

A. Memory-Stop Balancing Valves:

1. Standard: MSS SP-110 for two-piece, copper-alloy ball valves.
2. Pressure Rating: **400-psig** minimum CWP.
3. Size: **NPS 2** or smaller.
4. Body: Copper alloy.
5. Port: Standard or full port.
6. Ball: Chrome-plated brass.
7. Seats and Seals: Replaceable.
8. End Connections: Solder joint or threaded.
9. Handle: Vinyl-covered steel with memory-setting device.

2.07 TEMPERATURE-ACTUATED, WATER MIXING VALVES

A. Water-Temperature Limiting Devices:

1. Standard: ASSE 1017.
2. Pressure Rating: **125 psig**.
3. Type: Thermostatically controlled, water mixing valve.
4. Material: Bronze body with corrosion-resistant interior components.
5. Connections: Threaded union inlets and outlet.
6. Accessories: Check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
7. Tempered-Water Setting: scheduled
8. Tempered-Water Design Flow Rate: scheduled
9. Valve Finish: Chrome plated.

2.08 STRAINERS FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers:

1. Pressure Rating: 125 psig minimum unless otherwise indicated.
2. Body: Bronze for NPS 2 and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved, epoxy coated and for NPS 2-1/2 and larger.
3. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
4. Screen: Stainless steel with round perforations unless otherwise indicated.
5. Perforation Size:
 - a. Strainers NPS 2 and Smaller: 0.020 inch.
 - b. Strainers NPS 2-1/2 to NPS 4: 0.045 inch.
6. Drain: Factory-installed, hose-end drain valve.

2.09 HOSE BIBBS

A. Hose Bibbs (HB):

1. Standard: ASME A112.18.1 for sediment faucets.
2. Body Material: Bronze.
3. Seat: Bronze, replaceable.
4. Supply Connections: NPS 1/2 or NPS 3/4 threaded or solder-joint inlet.
5. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
6. Pressure Rating: 125 psig.
7. Vacuum Breaker: Integral nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
8. Finish for Equipment Rooms: Rough bronze, or chrome or nickel plated.
9. Finish for Service Areas: Rough bronze
10. Finish for Finished Rooms: Chrome or nickel plated.
11. Operation for Equipment Rooms: Wheel handle or operating key.
12. Operation for Finished Rooms: Operating key.
13. Include operating key with each operating-key hose bibb.
14. Include wall flange with each chrome- or nickel-plated hose bibb.

2.10 WALL HYDRANTS

A. Nonfreeze Wall Hydrants (WH):

1. Standard: ASME A112.21.3M for concealed-outlet, self-draining wall hydrants.
2. Pressure Rating: 125 psig.
3. Operation: Loose key.
4. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
5. Inlet: NPS 3/4 or NPS 1.
6. Outlet: Concealed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
7. Box: Deep, flush mounted with cover.

8. Box and Cover Finish: Chrome plated.
9. Outlet: Exposed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
10. Nozzle and Wall-Plate Finish: Polished nickel bronze.
11. Operating Keys(s): Two with each wall hydrant.

2.11 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves;

1. Standard: MSS SP-110 for standard-port, two-piece ball valves.
2. Pressure Rating: 400-psig minimum CWP.
3. Size: NPS 3/4.
4. Body: Copper alloy.
5. Ball: Chrome-plated brass.
6. Seats and Seals: Replaceable.
7. Handle: Vinyl-covered steel.
8. Inlet: Threaded or solder joint.
9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

2.12 WATER-HAMMER ARRESTERS

A. Water-Hammer Arresters:

1. Standard: ASSE 1010 or PDI-WH 201.
2. Type: Metal bellows or Copper tube with piston.
3. Size: ASSE 1010, Sizes AA and A through F, or PDI-WH 201, Sizes A through F.

PART 3 - EXECUTION

3.01 INSTALLATION

- #### A. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.
1. Locate backflow preventers in same room as connected equipment or system.
 2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe-to-floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are unacceptable for this application.
 3. Do not install bypass piping around backflow preventers.

- B. Install water regulators with inlet and outlet shutoff valves and bypass with memory-stop balancing valve. Install pressure gages on inlet and outlet.
- C. Install balancing valves in locations where they can easily be adjusted.
- D. Install temperature-actuated, water mixing valves with check stops or shutoff valves on inlets and with shutoff valve on outlet.
- E. Install Y-pattern strainers for water on supply side of each water pressure-reducing valve.
- F. Set nonfreeze, nondraining-type post hydrants in concrete or pavement.
- G. Set freeze-resistant yard hydrants with riser pipe in concrete or pavement. Do not encase canister in concrete.
- H. Install water-hammer arresters in water piping according to PDI-WH 201.
- I. Install supply-type, trap-seal primer valves with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow.
- J. Install drainage-type, trap-seal primer valves as lavatory trap with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting.

3.02 CONNECTIONS

- A. Comply with requirements for ground equipment in Section 26 05 26 "Grounding and Bonding for Electrical Systems."
- B. Fire-retardant-treated-wood blocking is specified in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables" for electrical connections.

3.03 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Test each backflow device according to authorities having jurisdiction and the device's reference standard.
- B. Domestic water piping specialties will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

3.04 ADJUSTING

- A. Set field-adjustable pressure set points of water pressure-reducing valves.

- B. Set field-adjustable flow set points of balancing valves.
- C. Set field-adjustable temperature set points of temperature-actuated, water mixing valves.

END OF SECTION 22 11 19

SECTION 22 11 23
DOMESTIC WATER PUMPS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Horizontally mounted, in-line, close-coupled centrifugal pumps.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. LEED Submittals:
1. Product Data for Prerequisite EA 2: Documentation indicating that units comply with applicable requirements in ASHRAE/IESNA 90.1, without amendments, Section 7 - "Service Water Heating."

1.03 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.04 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. UL Compliance: Comply with UL 778 for motor-operated water pumps.

PART 2 - PRODUCTS

2.01 HORIZONTALLY MOUNTED, IN-LINE, CLOSE-COUPLED CENTRIFUGAL PUMPS

- A. Description: Factory-assembled and -tested, in-line, single-stage, close-coupled, overhung-impeller centrifugal pumps designed for installation with pump and motor shaft mounted horizontal.
- B. Pump Construction:

1. Casing: Radially split with threaded companion-flange connections for pumps with NPS 2 (DN 50) pipe connections and flanged connections for pumps with NPS 2-1/2 (DN 65) pipe connections.
 2. Impeller: Statically and dynamically balanced, closed, and keyed to shaft.
 3. Shaft and Shaft Sleeve: Steel shaft with deflector, with copper-alloy shaft sleeve. Include water slinger on shaft between motor and seal.
 4. Seal: Mechanical, with carbon-steel rotating ring, stainless-steel spring, ceramic seat, and rubber bellows and gasket.
 5. Bearings: Oil-lubricated; bronze-journal or ball type.
 6. Shaft Coupling: Flexible, capable of absorbing torsional vibration and shaft misalignment.
- C. Motor: Single speed, with grease-lubricated ball bearings; and resiliently or rigidly mounted to pump casing.
- D. Capacities and Characteristics: as shown on drawing schedules.

2.02 MOTORS

- A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 22 05 13 "Common Motor Requirements for Plumbing Equipment."
1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

2.03 CONTROLS

- A. Thermostats: Electric; adjustable for control of hot-water circulation pump.
1. Type: Water-immersion temperature sensor, for installation in piping.
 2. Range: 50 to 125 deg F (10 to 52 deg C).
 3. Enclosure: NEMA 250, Type 4X.
 4. Operation of Pump: On or off.
 5. Transformer: Provide if required.
 6. Power Requirement: 24 V, ac.
 7. Settings: Start pump at 105 deg F (41 deg C)]
- B. Timers: Electric, for control of hot-water circulation pump.
1. Type: Programmable, seven-dayclock with manual override on-off switch.
 2. Enclosure: NEMA 250, Type 1, suitable for wall mounting.
 3. Operation of Pump: On or off.
 4. Transformer: Provide if required.
 5. Power Requirement: 24-V ac.
 6. Programmable Sequence of Operation: Up to two on-off cycles each day for seven days.

PART 3 - EXECUTION**3.01 PUMP INSTALLATION**

- A. Comply with HI 1.4.
- B. Install horizontally mounted, in-line, close-coupled centrifugal pumps with shaft horizontal.
- C. Install continuous-thread hanger rods and spring hangers of size required to support pump weight.
- D. Install thermostats in hot-water return piping.
- E. Install timers on wall adjacent to unit.

3.02 CONNECTIONS

- A. Comply with requirements for piping specified in Section 22 11 16 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to pumps to allow service and maintenance.
- C. Connect domestic water piping to pumps. Install suction and discharge piping equal to or greater than size of pump nozzles.
 - 1. Install flexible connectors adjacent to pumps in suction and discharge piping of the following pumps:
 - a. Horizontally mounted, in-line, close-coupled centrifugal pumps.
 - b. Comply with requirements for flexible connectors specified in Section 22 11 16 "Domestic Water Piping."
 - 2. Install shutoff valve and strainer on suction side of each pump, and check, shutoff, and throttling valves on discharge side of each pump. Install valves same size as connected piping. Comply with requirements for valves specified in Section 22 05 23
 - 3. Install pressure gage at suction and at discharge of each pump. Install at integral pressure-gage tappings where provided or install pressure-gage connectors in suction and discharge piping around pumps. Comply with requirements for pressure gages and snubbers specified in Section 22 05 19 "Meters and Gages for Plumbing Piping."
- D. Connect thermostats and timers to pumps that they control.

3.03 ADJUSTING

- A. Adjust domestic water pumps to function smoothly, and lubricate as recommended by manufacturer.

- B. Adjust initial temperature set points.
- C. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

END OF SECTION 22 11 23

SECTION 22 13 16
SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Pipe, tube, and fittings.
 - 2. Specialty pipe fittings.

1.02 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Field quality-control reports.

1.03 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF/ANSI 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping and "NSF-sewer" for plastic sewer piping.

PART 2 - PRODUCTS

2.01 PIPING MATERIALS

- A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.02 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 74, Service class.
- B. Gaskets: ASTM C 564, rubber.

2.03 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 888 or CISPI 301.
- B. CISPI, Hubless-Piping Couplings:
 - 1. Standards: ASTM C 1277 and CISPI 310.
 - 2. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.04 COPPER TUBE AND FITTINGS

- A. Copper DWV Tube: ASTM B 306, drainage tube, drawn temper.
- B. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.
- C. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.
 - 1. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
 - 2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
- D. Solder: ASTM B 32, lead free with ASTM B 813, water-flushable flux.

2.05 ABS PIPE AND FITTINGS

- A. Solid-Wall ABS Pipe: ASTM D 2661, Schedule 40.
- B. ABS Socket Fittings: ASTM D 2661, made to ASTM D 3311, drain, waste, and vent patterns.
- C. Solvent Cement: ASTM D 2235.
 - 1. ABS solvent cement shall have a VOC content of 325 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.06 PVC PIPE AND FITTINGS

- A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.
- B. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.
- C. Adhesive Primer: ASTM F 656.

1. Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

D. Solvent Cement: ASTM D 2564.

1. PVC solvent cement shall have a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.07 SPECIALTY PIPE FITTINGS

A. Transition Couplings:

1. General Requirements: Fitting or device for joining piping with small differences in OD's or of different materials. Include end connections same size as and compatible with pipes to be joined.
2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
3. Unshielded, Nonpressure Transition Couplings:
 - a. Standard: ASTM C 1173.
 - b. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
 - c. Sleeve Materials:
 - 1) For Cast-Iron Soil Pipes: ASTM C 564, rubber.
 - 2) For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
 - 3) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

PART 3 - EXECUTION

3.01 EARTH MOVING

- A. Comply with requirements for excavating, trenching, and backfilling specified in Section 31 20 00 "Earth Moving."

3.02 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.
- B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- E. Install piping at indicated slopes.
- F. Install piping free of sags and bends.
- G. Install fittings for changes in direction and branch connections.
- H. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
- I. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.
- J. Install soil and waste drainage and vent piping at the following minimum slopes unless otherwise indicated:
 - 1. Building Sanitary Drain: 2 percent downward in direction of flow for piping **NPS 3** and smaller; 1 percent downward in direction of flow for piping **NPS 4** and larger.
 - 2. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow.
 - 3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.
- K. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
- L. Install aboveground copper tubing according to CDA's "Copper Tube Handbook."
- M. Install aboveground ABS piping according to ASTM D 2661.
- N. Install aboveground PVC piping according to ASTM D 2665.
- O. Install underground ABS AND PVC piping according to ASTM D 2321.
- P. Plumbing Specialties:

1. Install backwater valves in sanitary waste gravity-flow piping. Comply with requirements for backwater valves specified in Section 22 13 19 "Sanitary Waste Piping Specialties."
2. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary drainage gravity-flow piping. Comply with requirements for cleanouts specified in Section 22 13 19 "Sanitary Waste Piping Specialties."
3. Install drains in sanitary drainage gravity-flow piping. Comply with requirements for drains specified in Section 22 13 19 "Sanitary Waste Piping Specialties."

- Q. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
- R. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 22 05 17 "Sleeves and Sleeve Seals for Plumbing Piping."
- S. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 22 05 17 "Sleeves and Sleeve Seals for Plumbing Piping."
- T. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 22 05 18 "Escutcheons for Plumbing Piping."

3.03 JOINT CONSTRUCTION

- A. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
- B. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.
- C. Join copper tube and fittings with soldered joints according to ASTM B 828. Use ASTM B 813, water-flushable, lead-free flux and ASTM B 32, lead-free-alloy solder.
- D. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.
- E. Plastic, Nonpressure-Piping, Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
 2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 Appendixes.
 3. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 Appendixes.

3.04 SPECIALTY PIPE FITTING INSTALLATION

A. Transition Couplings:

1. Install transition couplings at joints of piping with small differences in OD's.
2. In Drainage Piping: Unshielded, nonpressure transition couplings.

3.05 VALVE INSTALLATION

A. Backwater Valves: Install backwater valves in piping subject to backflow.

1. Horizontal Piping: Horizontal backwater valves. Use normally closed type unless otherwise indicated.
2. Floor Drains: Drain outlet backwater valves unless drain has integral backwater valve.
3. Install backwater valves in accessible locations.
4. Comply with requirements for backwater valve specified in Section 22 13 19 "Sanitary Waste Piping Specialties."

3.06 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for seismic-restraint devices specified in Section 22 05 48 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

B. Comply with requirements for pipe hanger and support devices and installation specified in Section 22 05 29 "Hangers and Supports for Plumbing Piping and Equipment."

1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
2. Install stainless-steel pipe hangers for horizontal piping in corrosive environments.
3. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
4. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.
5. Vertical Piping: MSS Type 8 or Type 42, clamps.
6. Install individual, straight, horizontal piping runs:
 - a. **100 Feet** and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than **100 Feet**: MSS Type 43, adjustable roller hangers.
 - c. Longer Than **100 Feet** if Indicated: MSS Type 49, spring cushion rolls.
7. Multiple, Straight, Horizontal Piping Runs **100 Feet** or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
8. Base of Vertical Piping: MSS Type 52, spring hangers.

C. Support horizontal piping and tubing within **12 inches** of each fitting[, valve,] and coupling.

- D. Support vertical piping and tubing at base and at each floor.
 - E. Rod diameter may be reduced one size for double-rod hangers, with **3/8-inch** minimum rods.
 - F. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. **NPS 1-1/2 and NPS 2: 60 inches** with **3/8-inch** rod.
 - 2. **NPS 3: 60 inches** with **1/2-inch** rod.
 - 3. **NPS 4 and NPS 5: 60 inches** with **5/8-inch** rod.
 - 4. **NPS 6 and NPS 8: 60 inches** with **3/4-inch** rod.
 - 5. Spacing for **10-foot** lengths may be increased to **10 feet**. Spacing for fittings is limited to **60 inches**.
 - G. Install supports for vertical cast-iron soil piping every **15 feet**.
 - H. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
 - 1. **NPS 1-1/4: 72 inches** with **3/8-inch** rod.
 - 2. **NPS 1-1/2 and NPS 2: 96 inches** with **3/8-inch** rod.
 - 3. **NPS 2-1/2: 108 inches** with **1/2-inch** rod.
 - 4. **NPS 3 and NPS 5: 10 feet** with **1/2-inch** rod.
 - 5. **NPS 6: 10 feet** with **5/8-inch** rod.
 - 6. **NPS 8: 10 feet** with **3/4-inch** rod.
 - I. Install supports for vertical copper tubing every **10 feet**.
 - J. Install hangers for ABS and PVC piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. **NPS 1-1/2 and NPS 2: 48 inches** with **3/8-inch** rod.
 - 2. **NPS 3: 48 inches** with **1/2-inch** rod.
 - 3. **NPS 4 and NPS 5: 48 inches** with **5/8-inch** rod.
 - 4. **NPS 6 and NPS 8: 48 inches** with **3/4-inch** rod.
 - K. Install supports for vertical ABS and PVC piping every **48 inches**.
 - L. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.
- 3.07 CONNECTIONS
- A. Drawings indicate general arrangement of piping, fittings, and specialties.
 - B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.
 - C. Connect drainage and vent piping to the following:

1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
 2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
 3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.
 4. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
 5. Install horizontal backwater valves with cleanout cover flush with floor.
 6. Comply with requirements for backwater valves, cleanouts and drains specified in Section 22 13 19 "Sanitary Waste Piping Specialties."
 7. Equipment: Connect drainage piping as indicated. Provide shutoff valve if indicated and union for each connection. Use flanges instead of unions for connections **NPS 2-1/2** and larger.
- D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.
- E. Make connections according to the following unless otherwise indicated:
1. Install unions, in piping **NPS 2** and smaller, adjacent to each valve and at final connection to each piece of equipment.
 2. Install flanges, in piping **NPS 2-1/2** and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.08 IDENTIFICATION

- A. Identify exposed sanitary waste and vent piping. Comply with requirements for identification specified in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

3.09 FIELD QUALITY CONTROL

- A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
- C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

- D. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping except outside leaders on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than **10-foot head of water**. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
 4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of **1-inch wg**. Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.
 5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 6. Prepare reports for tests and required corrective action.

3.10 CLEANING AND PROTECTION

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.
- D. Exposed ABS and PVC Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.

3.11 PIPING SCHEDULE

- A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.
- B. Aboveground, soil, waste and vent piping shall be any of the following:
 1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 2. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.
 3. Copper DWV tube, copper drainage fittings, and soldered joints.
 4. Solid-wall ABS pipe; ABS socket fittings, and solvent-cemented joints.

5. Solid-wall PVC pipe; PVC socket fittings, and solvent-cemented joints.
 6. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.
- C. Underground, soil, waste, and vent piping shall be any of the following:
1. Service class, cast-iron soil piping; gaskets; and gasketed joints.
 2. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.
 3. Solid wall ABS pipe, ABS socket fittings, and solvent-cemented joints.
 4. Solid wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
 5. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.

END OF SECTION 22 13 16

SECTION 22 13 19**SANITARY WASTE PIPING SPECIALTIES****PART 1 - GENERAL****1.01 SUMMARY**

- A. Section Includes:
1. Backwater valves.
 2. Cleanouts.
 3. Floor drains.
 4. Roof flashing assemblies.
 5. Miscellaneous sanitary drainage piping specialties.
 6. Flashing materials.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

1.03 QUALITY ASSURANCE

- A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

PART 2 - PRODUCTS**2.01 BACKWATER VALVES**

- A. Horizontal, Cast-Iron Backwater Valves:
1. Standard: ASME A112.14.1.
 2. Size: Same as connected piping.
 3. Body: Cast iron.
 4. Cover: Cast iron with bolted or threaded access check valve.
 5. End Connections: Hub and spigot or hubless.
 6. Type Check Valve: Removable, bronze, swing check, factory assembled or field modified to hang open for airflow unless subject to backflow condition.
 7. Extension: ASTM A 74, Service class; full-size, cast-iron, soil-pipe extension to field-installed cleanout at floor; replaces backwater valve cover.
- B. Drain-Outlet Backwater Valves:
1. Size: Same as floor drain outlet.

2. Body: Cast iron or bronze made for vertical installation in bottom outlet of floor drain.
3. Check Valve: Removable ball float.
4. Inlet: Threaded.
5. Outlet: Threaded or spigot.

2.02 CLEANOUTS

A. Exposed Cast-Iron Cleanouts (CO):

1. Standard: ASME A112.36.2M for cast iron for cleanout test tee.
2. Size: Same as connected drainage piping
3. Body Material: Hub-and-spigot, cast-iron soil pipe T-branch or Hubless, cast-iron soil pipe test tee as required to match connected piping.
4. Closure: Countersunk or raised-head, brass plug.
5. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

B. Cast-Iron Floor Cleanouts (FCO):

1. Standard: ASME A112.36.2M for threaded, adjustable housing cleanout.
2. Size: Same as connected branch.
3. Body or Ferrule: Cast iron.
4. Outlet Connection: Threaded.
5. Closure: Brass plug with tapered threads.
6. Adjustable Housing Material: Cast iron with threads, set-screws or other device.
7. Frame and Cover Material and Finish: Nickel-bronze, copper alloy.
8. Frame and Cover Shape: Round.
9. Top Loading Classification: Heavy Duty.
10. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.

C. Cast-Iron Wall Cleanouts (WCO):

1. Standard: ASME A112.36.2M. Include wall access.
2. Size: Same as connected drainage piping.
3. Body: Hub-and-spigot, cast-iron soil pipe T-branch or Hubless, cast-iron soil pipe test tee as required to match connected piping.
4. Closure: Countersunk or raised-head, brass plug.
5. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
6. Wall Access: Round, flat, chrome-plated brass or stainless-steel cover plate with screw.
7. Wall Access: Round, nickel-bronze, copper-alloy, or stainless-steel wall-installation frame and cover.

2.03 FLOOR DRAINS

- A. Cast-Iron Floor Drains : As Scheduled on the Drawings and herein.

1. Standard: ASME A112.6.3 with backwater valve.
2. Pattern: Floor drain.
3. Body Material: Gray iron.
4. Seepage Flange: as required
5. Anchor Flange: as required.
6. Clamping Device: as required.
7. Outlet: Bottom.
8. Backwater Valve: Drain-outlet type.
9. Coating on Interior and Exposed Exterior Surfaces: Not required.
10. Sediment Bucket: Not required.
11. Top or Strainer Material: Bronze.
12. Top of Body and Strainer Finish: Nickel bronze.
13. Top Shape: Square.
14. Top Loading Classification: Heavy Duty.
15. Inlet Fitting: Gray iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.

2.04 TRENCH DRAINS

- A. Trench Drains TD-1: Modular with plastic catch basins as defined on drawings. Coordinate installation with structural foundation.

2.05 ROOF FLASHING ASSEMBLIES

- A. Roof Flashing Assemblies:
 1. Description: Manufactured assembly made of 4.0-lb/sq. ft., 0.0625-inch thick, lead flashing collar and skirt extending at least 6 inches from pipe, with galvanized-steel boot reinforcement and counterflashing fitting.
 - a. Open-Top Vent Cap: Without cap.
 - b. Low-Silhouette Vent Cap: With vandal-proof vent cap.
 - c. Extended Vent Cap: With field-installed, vandal-proof vent cap.

2.06 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

- A. Open Drains:
 1. Description: Shop or field fabricate from ASTM A 74, Service class, hub-and-spigot, cast-iron, soil-pipe fittings. Include P-trap, hub-and-spigot riser section; and where required, increaser fitting joined with ASTM C 564, rubber gaskets.
 2. Size: Same as connected waste piping.
- B. Deep-Seal Traps:
 1. Description: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.
 2. Size: Same as connected waste piping.

-
- a. NPS 2: 4-inch- minimum water seal.
 - b. NPS 2-1/2 and Larger: 5-inch- minimum water seal.
- C. Floor-Drain, Trap-Seal Primer Fittings:
- 1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
 - 2. Size: Same as floor drain outlet with NPS 1/2 side inlet.
- D. Air-Gap Fittings:
- 1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.
 - 2. Body: Bronze or cast iron.
 - 3. Inlet: Opening in top of body.
 - 4. Outlet: Larger than inlet.
 - 5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.
- E. Sleeve Flashing Device:
- 1. Description: Manufactured, cast-iron fitting, with clamping device, that forms sleeve for pipe floor penetrations of floor membrane. Include galvanized-steel pipe extension in top of fitting that will extend 1 inch above finished floor and galvanized-steel pipe extension in bottom of fitting that will extend through floor slab.
 - 2. Size: As required for close fit to riser or stack piping.
- F. Stack Flashing Fittings:
- 1. Description: Counterflashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.
 - 2. Size: Same as connected stack vent or vent stack.
- G. Vent Caps:
- 1. Description: Cast-iron body with threaded or hub inlet and vandal-proof design. Include vented hood and setscrews to secure to vent pipe.
 - 2. Size: Same as connected stack vent or vent stack.
- 2.07 FLASHING MATERIALS
- A. Lead Sheet: ASTM B 749, Type L51121, copper bearing, with the following minimum weights and thicknesses, unless otherwise indicated:
- 1. General Use: 4.0-lb/sq. ft., 0.0625-inch thickness.
 - 2. Vent Pipe Flashing: 3.0-lb/sq. ft., 0.0469-inch thickness.
 - 3. Burning: 6-lb/sq. ft., 0.0938-inch thickness.
- B. Fasteners: Metal compatible with material and substrate being fastened.

- C. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.
- D. Solder: ASTM B 32, lead-free alloy.
- E. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install backwater valves in building drain piping. For interior installation, provide cleanout deck plate flush with floor and centered over backwater valve cover, and of adequate size to remove valve cover for servicing.
- B. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
 - 1. Size same as drainage piping up to **NPS 4**. Use **NPS 4** for larger drainage piping unless larger cleanout is indicated.
 - 2. Locate at each change in direction of piping greater than 45 degrees.
 - 3. Locate at minimum intervals of **50 feet** for piping **NPS 4** and smaller and **100 feet** for larger piping.
 - 4. Locate at base of each vertical soil and waste stack.
- C. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
- D. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- E. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
 - 1. Position floor drains for easy access and maintenance.
 - 2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:
 - a. Radius, **30 Inches** or Less: Equivalent to 1 percent slope, but not less than **1/4-inch** total depression.
 - b. Radius, **30 to 60 Inches**: Equivalent to 1 percent slope.
 - c. Radius, **60 Inches** or Larger: Equivalent to 1 percent slope, but not greater than **1-inch** total depression.
 - 3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
 - 4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

- F. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof.
- G. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof.
- H. Assemble open drain fittings and install with top of hub 2 inches above floor.
- I. Install deep-seal traps on floor drains and other waste outlets in the non restroom areas.
- J. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.
- K. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.
- L. Install vent caps on each vent pipe passing through roof.
- M. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.
- N. Coordinate installation of trench drains and catch basins with structural foundation.

3.02 CONNECTIONS

- A. Comply with requirements in Section 22 13 16 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment to allow service and maintenance.
- C. Connect to catch basin on trench drains per manufacturer recommendation.

3.03 FLASHING INSTALLATION

- A. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:
 - 1. Lead Sheets: Burn joints of lead sheets **6.0-lb/sq. ft., 0.0938-inch** thickness or thicker. Solder joints of lead sheets **4.0-lb/sq. ft., 0.0625-inch** thickness or thinner.
- B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
 - 1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of **10 inches**, and skirt or flange extending at least **8 inches** around pipe.
 - 2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least **8 inches** around sleeve.

-
3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least **8 inches** around specialty.
 - C. Set flashing on floors and roofs in solid coating of bituminous cement.
 - D. Secure flashing into sleeve and specialty clamping ring or device.
 - E. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings, according to Section 07 62 00 "Sheet Metal Flashing and Trim."
 - F. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.

3.04 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 22 13 19

SECTION 22 13 23**SANITARY WASTE INTERCEPTORS****PART 1 - GENERAL****1.01 SUMMARY**

- A. Section Includes:
1. Oil interceptors.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of metal interceptor indicated.
- B. Shop Drawings: For each type and size of precast-concrete interceptor indicated.

PART 2 - PRODUCTS**2.01 OIL INTERCEPTORS**

- A. Oil Interceptors: Factory-fabricated, cast-iron or steel body; with removable sediment bucket or strainer, baffles, vents, and flow-control fitting on inlet.
1. Inlet, Outlet, Vent, and Waste-Oil Outlet Piping Connections: Hub, hubless, or threaded, unless otherwise indicated.
 2. Extension: Cast-iron or steel shroud, full size of interceptor, extending from top of interceptor to grade.
 3. Cover: Cast iron or steel, with steel reinforcement to provide ASTM C 890, heavy truck traffic load.
 4. Comply with requirements in Section 23 11 13 "Facility Fuel-Oil Piping" for waste-oil storage tank and piping
- B. Capacities and Characteristics: per drawings

2.02 PRECAST-CONCRETE MANHOLE RISERS

- A. Precast-Concrete Manhole Risers: **ASTM C 478 (ASTM C 478M)**, with rubber-gasket joints.
1. Structural Design Loads:
 - a. Light-Traffic Load: Comply with ASTM C 890, A-8 (ASSHTO HS10-44).
 - b. Medium-Traffic Load: Comply with ASTM C 890, A-12 (ASSHTO HS15-44).

- c. Heavy-Traffic Load: Comply with ASTM C 890, A-16 (ASSHTO HS20-44).
 - d. Walkway Load: Comply with ASTM C 890, A-03.
2. Length: From top of underground concrete structure to grade.
 3. Riser Sections: 3-inch (75-mm) minimum thickness and 24-inch (600-mm) diameter.
 4. Top Section: Eccentric cone, unless otherwise indicated. Include top of cone to match grade ring size.
 5. Gaskets: ASTM C 443 (ASTM C 443M), rubber.
 6. Steps: [Individual FRP steps or FRP ladder] [Individual FRP steps, FRP ladder, or ASTM A 615/A 615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D 4101, PP] [ASTM A 615/A 615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D 4101, PP] <Insert material>, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12- to 16-inch (300- to 400-mm) intervals.
- B. Grade Rings: Reinforced-concrete rings, 6- to 9-inch (150- to 225-mm) total thickness, diameter matching manhole frame and cover, and height as required to adjust the manhole frame and cover to indicated elevation and slope.
- C. Manhole Frames and Covers: Ferrous; 24-inch (610-mm) ID by 7- to 9-inch (175- to 225-mm) riser with 4-inch- (100-mm-) minimum width flange and 26-inch- (660-mm-) diameter cover.
1. Ductile Iron: ASTM A 536, Grade 60-40-18, unless otherwise indicated.
 2. Gray Iron: ASTM A 48, Class 35, unless otherwise indicated.
 3. Include indented top design with lettering cast into cover, using wording equivalent to the following:

PART 3 - EXECUTION

3.01 EARTHWORK

- A. Excavating, trenching, and backfilling are specified in Section 31 20 00 "Earth Moving."

3.02 INSTALLATION

- A. Install precast-concrete interceptors according to ASTM C 891. Set level and plumb.
- B. Install manhole risers from top of underground concrete interceptors to manholes and gratings at finished grade.
- C. Set tops of manhole frames and covers flush with finished surface in pavements. Set metal interceptors level and plumb.

3.03 CONNECTIONS

- A. Piping installation requirements are specified in Section 22 13 16 "Sanitary Waste and Vent Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Make piping connections between interceptors and piping systems.

3.04 IDENTIFICATION

- A. Identification materials and installation are specified in Section 31 20 00 "Earth Moving." Arrange for installation of green warning tapes directly over piping and at outside edges of underground interceptors.
 - 1. Use warning tapes or detectable warning tape over ferrous piping.
 - 2. Use detectable warning tape over nonferrous piping and over edges of underground structures.

END OF SECTION 22 13 23

SECTION 22 14 13
FACILITY STORM DRAINAGE PIPING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
1. Pipe, tube, and fittings.
 2. Specialty pipe fittings.

1.02 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Field quality-control reports.

1.03 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF/ANSI 14, "Plastics Piping System Components and Related Materials," for plastic piping components. Include marking with "NSF-drain" for plastic drain piping and "NSF-sewer" for plastic sewer piping.

PART 2 - PRODUCTS

2.01 PIPING MATERIALS

- A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.02 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 74, Service class.
- B. Gaskets: ASTM C 564, rubber.

2.03 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 888 or CISPI 301.
- B. CISPI, Hubless-Piping Couplings:
 - 1. Standards: ASTM C 1277 and CISPI 310.
 - 2. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.
- C. Heavy-Duty, Hubless-Piping Couplings:
 - 1. Standards: ASTM C 1277 and ASTM C 1540.
 - 2. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.04 PVC PIPE AND FITTINGS

- A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.
- B. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.
- C. Adhesive Primer: ASTM F 656.
- D. Solvent Cement: ASTM D 2564.

2.05 SPECIALTY PIPE FITTINGS

- A. Transition Couplings:
 - 1. General Requirements: Fitting or device for joining piping with small differences in OD's or of different materials. Include end connections same size as and compatible with pipes to be joined.
 - 2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified-piping-system fitting.
 - 3. Unshielded, Nonpressure Transition Couplings:
 - a. Standard: ASTM C 1173.
 - b. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
 - c. Sleeve Materials:
 - 1) For Cast-Iron Soil Pipes: ASTM C 564, rubber.
 - 2) For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
 - 3) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.
 - 4. Shielded, Nonpressure Transition Couplings:

- a. Standard: ASTM C 1460.
- b. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

PART 3 - EXECUTION

3.01 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations from layout are approved on coordination drawings.
- B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- E. Install piping at indicated slopes.
- F. Install piping free of sags and bends.
- G. Install fittings for changes in direction and branch connections.
- H. Make changes in direction for storm drainage piping using appropriate branches, bends, and long-sweep bends. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
- I. Lay buried building storm drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.
- J. Install storm drainage piping at the following minimum slopes unless otherwise indicated:
 1. Horizontal Storm-Drainage Piping: 1 percent downward in direction of flow.
- K. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

1. Install encasement on underground piping according to ASTM A 674 or AWWA C105.
 - L. Install aboveground copper tubing according to CDA's "Copper Tube Handbook."
 - M. Install aboveground PVC piping according to ASTM D 2665.
 - N. Install underground PVC piping according to ASTM D 2321.
 - O. Plumbing Specialties:
 1. Install backwater valves in storm drainage gravity-flow piping. Comply with requirements for backwater valves specified in Section 22 14 23 "Storm Drainage Piping Specialties."
 2. Install cleanouts at grade and extend to where building storm drains connect to building storm sewers in storm drainage gravity-flow piping. Install cleanout fitting with closure plug inside the building in storm drainage force-main piping. Comply with requirements for cleanouts specified in Section 22 14 23 "Storm Drainage Piping Specialties."
 3. Install drains in storm drainage gravity-flow piping. Comply with requirements for drains specified in Section 22 14 23 "Storm Drainage Piping Specialties."
 - P. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
 - Q. Install sleeves for piping penetrations of walls, ceilings, and floors per requirements for sleeves specified in Section 22 05 17 "Sleeves and Sleeve Seals for Plumbing Piping."
 - R. Install sleeve seals for piping penetrations of concrete walls and slabs per requirements for sleeve seals specified in Section 22 05 17 "Sleeves and Sleeve Seals for Plumbing Piping."
 - S. Install escutcheons for piping penetrations of walls, ceilings, and floors per requirements for escutcheons specified in Section 22 05 18 "Escutcheons for Plumbing Piping."
- 3.02 JOINT CONSTRUCTION
- A. Join hub-and-spigot, cast-iron soil piping with gasketed joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
 - B. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.
 - C. Join copper tube and fittings with soldered joints according to ASTM B 828 procedure. Use ASTM B 813, water-flushable, lead-free flux and ASTM B 32, lead-free-alloy solder.

- D. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.
- E. Plastic, Nonpressure-Piping, Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 - 1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
 - 2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 Appendixes.
 - 3. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 Appendixes.

3.03 SPECIALTY PIPE FITTING INSTALLATION

- A. Transition Couplings:
 - 1. Install transition couplings at joints of piping with small differences in OD's.
 - 2. In Drainage Piping: Unshielded or Shielded, nonpressure transition couplings.

3.04 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements for seismic-restraint devices specified in Section 22 05 48 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- B. Comply with requirements for pipe hanger and support devices and installation specified in Section 22 05 29 "Hangers and Supports for Plumbing Piping and Equipment."
 - 1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
 - 2. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
 - 3. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.
 - 4. Vertical Piping: MSS Type 8 or Type 42, clamps.
 - 5. Individual, Straight, Horizontal Piping Runs:
 - a. **100 Feet** and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than **100 Feet**: MSS Type 43, adjustable roller hangers.
 - c. Longer Than **100 Feet** if Indicated: MSS Type 49, spring cushion rolls.
 - 6. Multiple, Straight, Horizontal Piping Runs **100 Feet** or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 - 7. Base of Vertical Piping: MSS Type 52, spring hangers.
- C. Support horizontal piping and tubing within **12 inches** of each fitting and coupling.
- D. Support vertical piping and tubing at base and at each floor.

- E. Rod diameter may be reduced one size for double-rod hangers, with **3/8-inch** minimum rods.
- F. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. **NPS 1-1/2 and NPS 2: 60 inches** with **3/8-inch** rod.
 - 2. **NPS 3: 60 inches** with **1/2-inch** rod.
 - 3. **NPS 4 and NPS 5: 60 inches** with **5/8-inch** rod.
 - 4. **NPS 6 and NPS 8: 60 inches** with **3/4-inch** rod.
- G. Install supports for vertical cast-iron soil piping every **15 feet**.
- H. Install hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. **NPS 1-1/2 and NPS 2: 48 inches** with **3/8-inch** rod.
 - 2. **NPS 3: 48 inches** with **1/2-inch** rod.
 - 3. **NPS 4 and NPS 5: 48 inches** with **5/8-inch** rod.
- I. Install supports for vertical PVC piping every **48 inches**.
- J. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.05 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect interior storm drainage piping to exterior storm drainage piping. Use transition fitting to join dissimilar piping materials.
- C. Connect storm drainage piping to roof drains and storm drainage specialties.
 - 1. Install test tees (wall cleanouts) in conductors near floor, and floor cleanouts with cover flush with floor.
- D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

3.06 IDENTIFICATION

- A. Identify exposed storm drainage piping. Comply with requirements for identification specified in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

3.07 FIELD QUALITY CONTROL

- A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
 - 1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in.
 - 2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
- C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- D. Test storm drainage piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
 - 1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 - 2. Leave uncovered and unconcealed new, altered, extended, or replaced storm drainage piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 - 3. Test Procedure: Test storm drainage piping on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than **10-foot head of water**. From 15 minutes before inspection starts until completion of inspection, water level must not drop. Inspect joints for leaks.
 - 4. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 - 5. Prepare reports for tests and required corrective action.

3.08 CLEANING

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.

3.09 PIPING SCHEDULE

- A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.
- B. Aboveground storm drainage piping shall be any of the following:

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.
3. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
4. Dissimilar Pipe-Material Couplings: Unshielded or Shielded, nonpressure transition couplings.

C. Underground storm drainage piping shall be any of the following:

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.
3. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
4. Dissimilar Pipe-Material Couplings: Unshielded or Shielded, nonpressure transition couplings.

END OF SECTION 22 14 13

SECTION 22 14 23
STORM DRAINAGE PIPING SPECIALTIES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
1. Roof drains.
 2. Miscellaneous storm drainage piping specialties.
 3. Cleanouts.
 4. Flashing materials.

1.02 SUBMITTALS

- A. Product Data: For each type of product indicated.

1.03 QUALITY ASSURANCE

- A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

PART 2 - PRODUCTS

2.01 ROOF DRAINS

- A. General-Purpose Roof Drains RD and RD (O):
1. Standard: ASME A112.6.4, for general-purpose roof drains.
 2. Body Material: Cast iron.
 3. Dimension of Body: Nominal **14-inch** diameter.
 4. Combination Flashing Ring and Gravel Stop: Required.
 5. Flow-Control Weirs: Not required.
 6. Outlet: Bottom.
 7. Extension Collars: as required
 8. Underdeck Clamp: as required].
 9. Dome Material: Cast iron.
 10. Perforated Gravel Guard: Stainless steel
 11. Vandal-Proof Dome: Required.
 12. Water Dam: **2 inches** high on RD(O).

2.02 MISCELLANEOUS STORM DRAINAGE PIPING SPECIALTIES

A. Downspout Adaptors:

1. Description: Manufactured, gray-iron casting, for attaching to horizontal-outlet, parapet roof drain and to exterior, sheet metal downspout.
2. Size: Inlet size to match parapet drain outlet.

B. Downspout Boots:

1. Description: Manufactured, ASTM A 48/A 48M, gray-iron casting, with strap or ears for attaching to building; NPS 4 outlet; and shop-applied bituminous coating.
2. Size: Inlet size to match downspout and NPS 4 outlet.

C. Conductor Nozzles:

1. Description: Bronze body with threaded inlet and bronze wall flange with mounting holes.
2. Size: Same as connected conductor.

2.03 CLEANOUTS

A. Test Tees:

1. Standard: ASME A112.36.2M and ASTM A 74, ASTM A 888, or CISPI 301, for cleanout test tees.
2. Size: Same as connected drainage piping.
3. Body Material: Hub-and-spigot, cast-iron soil-pipe T-branch or hubless, cast-iron soil-pipe test tee as required to match connected piping.
4. Closure Plug: raised head, brass.
5. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

B. Wall Cleanouts:

1. Standard: ASME A112.36.2M, for cleanouts. Include wall access.
2. Size: Same as connected drainage piping.
3. Body Material: Hub-and-spigot, cast-iron soil-pipe T-branch or Hubless, cast-iron soil-pipe test tee as required to match connected piping.
4. Closure: Countersunk or raised-head, cast-iron plug.
5. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
6. Wall Access: Round, flat, chrome-plated brass or stainless-steel cover plate with screw.

2.04 FLASHING MATERIALS

A. Copper Sheet: ASTM B 152/B 152M, 12 oz./sq. ft.

B. Zinc-Coated Steel Sheet: ASTM A 653/A 653M, with 0.20 percent copper content and 0.04-inch minimum thickness unless otherwise indicated. Include G90 hot-dip galvanized, mill-phosphatized finish for painting if indicated.

- C. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-mil minimum thickness.
- D. Fasteners: Metal compatible with material and substrate being fastened.
- E. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.
- F. Solder: ASTM B 32, lead-free alloy.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install roof drains at low points of roof areas according to roof membrane manufacturer's written installation instructions.
 - 1. Install flashing collar or flange of roof drain to prevent leakage between drain and adjoining roofing. Maintain integrity of waterproof membranes where penetrated.
 - 2. Install expansion joints, if indicated, in roof drain outlets.
 - 3. Position roof drains for easy access and maintenance.
- B. Install downspout adapters on outlet of back-outlet parapet roof drains and connect to sheet metal downspouts.
- C. Install downspout boots at grade with top 12 inches above grade. Secure to building wall.
- D. Install conductor nozzles at exposed bottom of conductors where they spill onto grade.
- E. Install cleanouts in aboveground piping and building drain piping according to the following instructions unless otherwise indicated:
 - 1. Use cleanouts the same size as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
 - 2. Locate cleanouts at each change in direction of piping greater than 45 degrees.
 - 3. Locate cleanouts at base of each vertical soil and waste stack.
- F. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- G. Install test tees in vertical conductors and near floor.
- H. Install wall cleanouts in vertical conductors. Install access door in wall if indicated.
- I. Install sleeve flashing device with each conductor passing through floors with waterproof membrane.

3.02 CONNECTIONS

- A. Comply with requirements for piping specified in Section 22 14 13 "Facility Storm Drainage Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

3.03 FLASHING INSTALLATION

- A. Fabricate flashing from single piece of metal unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:
 - 1. Lead Sheets: Burn joints of 6.0-lb/sq. ft. lead sheets, 0.0938-inch thickness or thicker. Solder joints of 4.0-lb/sq. ft. lead sheets, 0.0625-inch thickness or thinner.
 - 2. Copper Sheets: Solder joints of copper sheets.
- B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
 - 1. Pipe Flashing: Sleeve type, matching the pipe size, with a minimum length of 10 inches and with skirt or flange extending at least 8 inches around pipe.
 - 2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
 - 3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.
- C. Set flashing on floors and roofs in solid coating of bituminous cement.
- D. Secure flashing into sleeve and specialty clamping ring or device.
- E. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.04 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 22 14 23

SECTION 22 14 29**SUMP PUMPS**

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Submersible sump pumps.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Wiring Diagrams: For power, signal, and control wiring.

1.03 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.04 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. UL Compliance: Comply with UL 778 for motor-operated water pumps.

PART 2 - PRODUCTS

2.01 SUBMERSIBLE SUMP PUMPS

- A. Submersible, Fixed-Position, Single-Seal Sump Pumps:
 - 1. Description: Factory-assembled and -tested sump-pump unit.
 - 2. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal sump pump as defined in HI 1.1-1.2 and HI 1.3.
 - 3. Pump Casing: Cast iron, with strainer inlet, legs that elevate pump to permit flow into impeller, and vertical discharge for piping connection.
 - 4. Impeller: Statically and dynamically balanced, ASTM A 532/A 532M, abrasion-resistant cast iron design for clear wastewater handling, and keyed and secured to shaft.

5. Pump and Motor Shaft: Stainless steel, with factory-sealed, grease-lubricated ball bearings.
6. Seal: Mechanical.
7. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.
 - a. Motor Housing Fluid: Oil.
8. Capacity: As scheduled on drawings.
9. Controls:
 - a. Enclosure: NEMA 250, Type 4X.
 - b. Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
 - c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
 - d. Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than 60 inches (1500 mm).
 - e. High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120-V ac, with transformer and contacts for remote alarm bell.
10. Control-Interface Features:
 - a. Remote Alarm Contacts: For remote alarm interface.
 - b. Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:
 - 1) On-off status of pump.
 - 2) Alarm status.

2.02 MOTORS

- A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 22 05 13 "Common Motor Requirements for Plumbing Equipment."
 1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
- B. Motors for submersible pumps shall be hermetically sealed.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Pump Installation Standard: Comply with HI 1.4 for installation of sump pumps.

END OF SECTION 22 14 29

SECTION 22 34 00**FUEL-FIRED, DOMESTIC-WATER HEATERS**

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Commercial, condensing, gas-fired, storage, domestic-water heaters.
 - 2. Domestic-water heater accessories.

1.02 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Commercial domestic-water heaters shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

1.03 SUBMITTALS

- A. Product Data: For each type and size of domestic-water heater indicated.
- B. LEED Submittals:
 - 1. Product Data for Prerequisite EA 2: Documentation indicating that units comply with applicable requirements in ASHRAE/IESNA 90.1, Section 7, "Service Water Heating."
- C. Shop Drawings:
 - 1. Wiring Diagrams: For power, signal, and control wiring.
- D. Seismic Qualification Certificates: For fuel-fired, domestic-water heaters, accessories, and components, from manufacturer.
- E. Product certificates.
- F. Domestic-Water Heater Labeling: Certified and labeled by testing agency acceptable to authorities having jurisdiction.
- G. Source quality-control reports.
- H. Field quality-control reports.
- I. Warranty: Sample of special warranty.

- J. Operation and maintenance data.

1.04 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASHRAE/IESNA Compliance: Fabricate and label fuel-fired, domestic-water heaters to comply with ASHRAE/IESNA 90.1.
- C. ASME Compliance:
1. Where ASME-code construction is indicated, fabricate and label commercial, domestic-water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
 2. Where ASME-code construction is indicated, fabricate and label commercial, finned-tube, domestic-water heaters to comply with ASME Boiler and Pressure Vessel Code: Section IV.
- D. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61, "Drinking Water System Components - Health Effects."

1.05 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of fuel-fired, domestic-water heaters that fail in materials or workmanship within specified warranty period.
1. Warranty Periods: From date of Substantial Completion.
 - a. Commercial, Gas-Fired, Storage, Domestic-Water Heaters:
 - 1) Storage Tank: Five years.
 - 2) Controls and Other Components: One year(s).
 - b. Commercial, Finned-Tube, Gas-Fired, Domestic-Water Heaters:
 - 1) Heat Exchanger: Five years.
 - 2) Controls and Other Components: One year(s).
 - 3) Separate Hot-Water Storage Tanks: Three years.
 - c. Compression Tanks: Five years.

PART 2 - PRODUCTS

- A. Commercial, Power-Burner, Gas-Fired, Storage, Domestic-Water Heaters:
1. Standard: ANSI Z21.10.3/CSA 4.3.
 2. Storage-Tank Construction: ASME-code steel with 150-psig (1035-kPa) working-pressure rating.

- a. Tappings: Factory fabricated of materials compatible with tank. Attach tappings to tank before testing.
 - 1) **NPS 2 (DN 50)** and Smaller: Threaded ends according to ASME B1.20.1.
 - 2) **NPS 2-1/2 (DN 65)** and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges and according to ASME B16.24 for copper and copper-alloy flanges.
 - b. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
 - c. Lining: Nickel plate, Phenolic coating or Sheet copper complying with NSF 61 barrier materials for potable-water tank linings, including extending lining into and through tank fittings and outlets.
3. Factory-Installed Storage-Tank Appurtenances:
- a. Anode Rod: Replaceable magnesium.
 - b. Dip Tube: Required unless cold-water inlet is near bottom of tank.
 - c. Drain Valve: Corrosion-resistant metal complying with ASSE 1005.
 - d. Insulation: Comply with ASHRAE/IESNA 90.1. Surround entire storage tank except connections and controls.
 - e. Jacket: Steel with enameled finish.
 - f. Burner: UL 795 for power-burner, gas-fired, domestic-water heaters and natural-gas fuel.
 - g. Automatic Ignition: ANSI Z21.20/CSA C22.2 No. 199, electric, automatic, gas-ignition system.
 - h. Temperature Control: Adjustable thermostat.
 - i. Safety Controls: Automatic, high-temperature-limit and low-water cutoff devices or systems.
 - j. Combination Temperature-and-Pressure Relief Valves: ANSI Z21.22/CSA 4.4-M. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select one relief valve with sensing element that extends into storage tank.
4. Special Requirements: NSF 5 construction.
5. High Efficiency (90% Plus) condensing type.

2.02 WATER HEATER ACCESSORIES

A. Domestic-Water Compression Tanks:

1. Description: Steel, pressure-rated tank constructed with welded joints and factory-installed butyl-rubber diaphragm. Include air precharge to minimum system-operating pressure at tank.
2. Construction:
 - a. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1 pipe thread.
 - b. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
 - c. Air-Charging Valve: Factory installed.

-
3. Capacity and Characteristics:
 - a. Working-Pressure Rating: 100 psig (690 kPa).
 - b. Capacity Acceptable: 10 gal. (37.9 L minimum).
 - c. Air Precharge Pressure: as recommended by MFR.
 - B. Drain Pans: Corrosion-resistant metal with raised edge. Comply with ANSI/CSA LC 3. Include dimensions not less than base of domestic-water heater, and include drain outlet not less than NPS 3/4 (DN 20) with ASME B1.20.1 pipe threads or with ASME B1.20.7 garden-hose threads.
 - C. Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE/IESNA 90.1.
 - D. Heat-Trap Fittings: ASHRAE 90.2.
 - E. Gas Shutoff Valves: ANSI Z21.15/CSA 9.1-M, manually operated. Furnish for installation in piping.
 - F. Gas Pressure Regulators: ANSI Z21.18/CSA 6.3, appliance type. Include 1/2-psig (3.5-kPa) pressure rating as required to match gas supply.
 - G. Automatic Gas Valves: ANSI Z21.21/CSA 6.5, appliance, electrically operated, on-off automatic valve.
 - H. Combination Temperature-and-Pressure Relief Valves: Include relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select relief valves with sensing element that extends into storage tank.
 1. Gas-Fired, Domestic-Water Heaters: ANSI Z21.22/CSA 4.4-M.
 2. Oil-Fired, Domestic-Water Heaters: ASME rated and stamped.
 - I. Pressure Relief Valves: Include pressure setting less than domestic-water heater working-pressure rating.
 1. Gas-Fired, Domestic-Water Heaters: ANSI Z21.22/CSA 4.4-M.
 2. Oil-Fired, Domestic-Water Heaters: ASME rated and stamped.
 - J. Vacuum Relief Valves: ANSI Z21.22/CSA 4.4-M.
 - K. Domestic-Water Heater Stands: Manufacturer's factory-fabricated steel stand for floor mounting, capable of supporting domestic-water heater and water. Provide dimension that will support bottom of domestic-water heater a minimum of 18 inches (457 mm) above the floor.
- 2.03 SOURCE QUALITY CONTROL
- A. Factory Tests: Test and inspect assembled domestic-water heaters specified to be ASME-code construction, according to ASME Boiler and Pressure Vessel Code.

- B. Hydrostatically test commercial domestic-water heaters to minimum of one and one-half times pressure rating before shipment.
- C. Domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Section 01 40 00 "Quality Requirements" for retesting and reinspecting requirements and Section 01 73 00 "Execution" for requirements for correcting the Work.
- D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.01 WATER HEATER INSTALLATION

- A. Commercial, Domestic-Water Heater Mounting: Install commercial domestic-water heaters on concrete base. Comply with requirements for concrete base specified in Section 03 30 00 "Cast-in-Place Concrete."
 - 1. Maintain manufacturer's recommended clearances.
 - 2. Arrange units so controls and devices that require servicing are accessible.
 - 3. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on **18-inch (450-mm)** centers around the full perimeter of concrete base.
 - 4. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 - 5. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 6. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 7. Anchor domestic-water heaters to substrate.
- B. Install domestic-water heaters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.
 - 1. Install shutoff valves on domestic-water-supply piping to domestic-water heaters and on domestic-hot-water outlet piping. Comply with requirements for shutoff valves specified in Section 22 05 23.12 "Ball Valves for Plumbing Piping," Section 22 05 23.13 "Butterfly Valves for Plumbing Piping," and Section 22 05 23.15 "Gate Valves for Plumbing Piping."
- C. Install gas-fired, domestic-water heaters according to NFPA 54.
 - 1. Install gas shutoff valves on gas supply piping to gas-fired, domestic-water heaters without shutoff valves.
 - 2. Install gas pressure regulators on gas supplies to gas-fired, domestic-water heaters without gas pressure regulators if gas pressure regulators are required to reduce gas pressure at burner.

3. Install automatic gas valves on gas supplies to gas-fired, domestic-water heaters if required for operation of safety control.
 4. Comply with requirements for gas shutoff valves, gas pressure regulators, and automatic gas valves specified in Section 23 11 23 "Facility Natural-Gas Piping."
- D. Install oil-fired, domestic-water heaters according to NFPA 31.
1. Install shutoff valves on fuel-oil supply piping to oil-fired water-heater burners without shutoff valves. Comply with requirements for shutoff valves specified in Section 23 05 23 "General-Duty Valves for HVAC Piping."
- E. Install commercial domestic-water heaters with seismic-restraint devices. Comply with requirements for seismic-restraint devices specified in Section 22 05 48 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- F. Install combination temperature-and-pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.
- G. Install combination temperature-and-pressure relief valves in water piping for domestic-water heaters without storage. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.
- H. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for domestic-water heaters that do not have tank drains. Comply with requirements for hose-end drain valves specified in Section 22 11 19 "Domestic Water Piping Specialties."
- I. Install thermometer on outlet piping of domestic-water heaters. Comply with requirements for thermometers specified in Section 22 05 19 "Meters and Gages for Plumbing Piping."
- J. Install piping-type heat traps on inlet and outlet piping of domestic-water heater storage tanks without integral or fitting-type heat traps.
- K. Fill domestic-water heaters with water.
- L. Charge domestic-water compression tanks with air.
- 3.02 CONNECTIONS
- A. Comply with requirements for domestic-water piping specified in Section 22 11 16 "Domestic Water Piping."
 - B. Comply with requirements for gas piping specified in Section 23 11 23 "Facility Natural-Gas Piping."

- C. Drawings indicate general arrangement of piping, fittings, and specialties.
- D. Where installing piping adjacent to fuel-fired, domestic-water heaters, allow space for service and maintenance of water heaters. Arrange piping for easy removal of domestic-water heaters.

3.03 IDENTIFICATION

- A. Identify system components. Comply with requirements for identification specified in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

3.04 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
 - 2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Section 01 40 00 "Quality Requirements" for retesting and reinspecting requirements and Section 01 73 00 "Execution" for requirements for correcting the Work.
- C. Prepare test and inspection reports.

3.05 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain domestic-water heaters.

END OF SECTION 22 34 00

SECTION 22 42 13.13
COMMERCIAL WATER CLOSETS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
1. Water closets.
 2. Flushometer valves.
 3. Toilet seats.

1.02 SUBMITTALS

- A. Product Data: For each type of product.
- B. LEED Submittals:
1. Product Data for Prerequisite WE 1, Credit WE 2, and Credit WE 3: Documentation indicating flow and water consumption requirements.
- C. Shop Drawings: Include diagrams for power, signal, and control wiring.
- D. Operation and Maintenance Data: For flushometer valves and electronic sensors to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.01 FLOOR-MOUNTED, BOTTOM-OUTLET WATER CLOSETS

2.02 WALL-MOUNTED WATER CLOSETS

- A. Water Closets (WC-1): Wall mounted, top spud.
1. Bowl:
 - a. Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5.
 - b. Material: Vitreous china.
 - c. Type: Siphon jet.
 - d. Style: Flushometer valve.
 - e. Height: Standard.
 - f. Rim Contour: Elongated.
 - g. Water Consumption: 1.28 gal. (4.8 L) per flush.
 - h. Spud Size and Location: NPS 1-1/2 (DN 40); top.

2. Flushometer Valve: as specified herein
3. Toilet Seat: as specified herein.
4. Support:
 - a. Standard: ASME A112.6.1M.
 - b. Description: Waste-fitting assembly, as required to match drainage piping material and arrangement with faceplates, couplings gaskets, and feet; bolts and hardware matching fixture.

B. Water Closets (WCH-1): Wall mounted, top spud, accessible.

1. Bowl:
 - a. Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5.
 - b. Material: Vitreous china.
 - c. Type: Siphon jet.
 - d. Style: Flushometer valve.
 - e. Rim Contour: Elongated.
 - f. Water Consumption: 1.28 gal. (4.8 L) per flush.
 - g. Spud Size and Location: NPS 1-1/2 (DN 40); top.
2. Flushometer Valve: as specified herein
3. Toilet Seat: as specified herein.
4. Support:
 - a. Standard: ASME A112.6.1M.
 - b. Description: Waste-fitting assembly, as required to match drainage piping material and arrangement with faceplates, couplings gaskets, and feet; bolts and hardware matching fixture.
 - c. Water-Closet Mounting Height: Handicapped/elderly according to ICC/ANSI A117.1.

2.03 FLUSHOMETER VALVES

A. Battery-Powered, Solenoid-Actuator, Piston Flushometer Valves:

1. Standard: ASSE 1037.
2. Minimum Pressure Rating: 125 psig.
3. Features: Include integral check stop and backflow-prevention device.
4. Material: Brass body with corrosion-resistant components.
5. Exposed Flushometer-Valve Finish: Chrome plated.
6. Style: Exposed.
7. Actuator: Solenoid complying with UL 1951; listed and labeled as defined in NFPA 70, by a qualified testing agency; and marked for intended location and application.
8. Trip Mechanism: Battery-powered electronic sensor complying with UL 1951; listed and labeled as defined in NFPA 70, by a qualified testing agency; and marked for intended location and application.
9. Consumption: 1.28. gallon per flush.
10. Minimum Inlet: NPS 1.
11. Minimum Outlet: NPS 1-1/4.

2.04 TOILET SEATS

A. Toilet Seats:

1. Standard: IAPMO/ANSI Z124.5.
2. Material: Plastic.
3. Type: Commercial (Standard).
4. Shape: Elongated rim, open front.
5. Hinge: Check.
6. Hinge Material: Noncorroding metal.
7. Seat Cover: Not required.
8. Color: White.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Water-Closet Installation:

1. Install level and plumb according to roughing-in drawings.
2. Install accessible, wall-mounted water closets at mounting height for handicapped/elderly, according to ICC/ANSI A117.1.

B. Support Installation:

1. Use carrier supports with waste-fitting assembly and seal.
2. Install wall-mounted, back-outlet water-closet supports with waste-fitting assembly and waste-fitting seals; and affix to building substrate.

C. Flushometer-Valve Installation:

1. Install flushometer-valve, water-supply fitting on each supply to each water closet.
2. Attach supply piping to supports or substrate within pipe spaces behind fixtures.
3. Install actuators in locations that are easy for people with disabilities to reach.

D. Install toilet seats on water closets.

E. Wall Flange and Escutcheon Installation:

1. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations and within cabinets and millwork.
2. Install deep-pattern escutcheons if required to conceal protruding fittings.
3. Comply with escutcheon requirements specified in Section 22 05 18 "Escutcheons for Plumbing Piping."

F. Joint Sealing:

1. Seal joints between water closets and walls and floors using sanitary-type, one-part, mildew-resistant silicone sealant.
2. Match sealant color to water-closet color.
3. Comply with sealant requirements specified in Section 07 92 00 "Joint Sealants."

3.02 CONNECTIONS

- A. Connect water closets with water supplies and soil, waste, and vent piping. Use size fittings required to match water closets.
- B. Comply with water piping requirements specified in Section 22 11 16 "Domestic Water Piping."
- C. Comply with soil and waste piping requirements specified in Section 22 13 16 "Sanitary Waste and Vent Piping."
- D. Where installing piping adjacent to water closets, allow space for service and maintenance.

3.03 ADJUSTING

- A. Operate and adjust water closets and controls. Replace damaged and malfunctioning water closets, fittings, and controls.
- B. Adjust water pressure at flushometer valves to produce proper flow.

3.04 CLEANING AND PROTECTION

- A. Clean water closets and fittings with manufacturers' recommended cleaning methods and materials.
- B. Install protective covering for installed water closets and fittings.
- C. Do not allow use of water closets for temporary facilities unless approved in writing by Owner.

END OF SECTION 22 42 13.13

SECTION 22 42 13.16
COMMERCIAL URINALS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
1. Urinals.
 2. Flushometer valves.

1.02 SUBMITTALS

- A. Product Data: For each type of product.
- B. LEED Submittals:
1. Product Data for Prerequisite WE 1, Credit WE 2, and Credit WE 3: Documentation indicating flow and water consumption requirements.
- C. Shop Drawings: Include diagrams for power, signal, and control wiring.
- D. Operation and Maintenance Data: For flushometer valves and electronic sensors to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.01 WALL-HUNG URINALS

- A. Urinals (U-1): Wall hung, back outlet, siphon jet, accessible.
1. Fixture:
 - a. Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5.
 - b. Material: Vitreous china.
 - c. Type: Siphon jet with extended shields].
 - d. Strainer or Trapway: Manufacturer's standard strainer with integral trap.
 - e. Water Consumption: Low.
 - f. Spud Size and Location: **NPS 3/4**; top.
 - g. Outlet Size and Location: **NPS 2**; back.
 - h. Color: White.
 2. Flushometer Valve: As specified herein
 3. Waste Fitting:
 - a. Standard: ASME A112.18.2/CSA B125.2 for coupling.
 - b. Size: **NPS 2**.

4. Support: ASME A112.6.1M, Type I, urinal carrier with fixture support plates and coupling with seal and fixture bolts and hardware matching fixture. Include rectangular, steel uprights.

2.02 URINAL FLUSHOMETER VALVES

A. Solenoid-Actuator, Diaphragm Flushometer Valves:

1. Standard: ASSE 1037.
2. Minimum Pressure Rating: 125 psig (860 kPa).
3. Features: Include integral check stop and backflow-prevention device.
4. Material: Brass body with corrosion-resistant components.
5. Exposed Flushometer-Valve Finish: Chrome plated.
6. Style: Exposed.
7. Actuator: Solenoid complying with UL 1951; listed and labeled as defined in NFPA 70, by a qualified testing agency; and marked for intended location and application.
8. Trip Mechanism: Battery-powered, electronic sensor complying with UL 1951; listed and labeled as defined in NFPA 70, by a qualified testing agency; and marked for intended location and application.
9. Consumption: 0.5 gal. (1.9 L) per flush.
10. Minimum Inlet: NPS 3/4 (DN 20).
11. Minimum Outlet: NPS 3/4 (DN 20).

B. Battery-Powered, Solenoid-Actuator, Piston Flushometer Valve:

1. Standard: ASSE 1037.
2. Minimum Pressure Rating: 125 psig.
3. Features: Include integral check stop and backflow-prevention device.
4. Material: Brass body with corrosion-resistant components.
5. Exposed Flushometer-Valve Finish: Chrome plated.
6. Style: Exposed.
7. Actuator: Solenoid complying with UL 1951; listed and labeled as defined in NFPA 70, by a qualified testing agency; and marked for intended location and application.
8. Trip Mechanism: Battery-powered electronic sensor complying with UL 1951; listed and labeled as defined in NFPA 70, by a qualified testing agency; and marked for intended location and application.
9. Consumption: 0.5 gal. per flush.
10. Minimum Inlet: NPS 3/4.
11. Minimum Outlet: NPS 3/4.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before urinal installation.
- B. Examine walls and floors for suitable conditions where urinals will be installed.

- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Urinal Installation:

1. Install urinals level and plumb according to roughing-in drawings.
2. Install wall-hung, back-outlet urinals onto waste fitting seals and attached to supports.
3. Install accessible, wall-mounted urinals at mounting height for the handicapped/elderly, according to ICC/ANSI A117.1.

B. Support Installation:

1. Install supports, affixed to building substrate, for wall-hung urinals.
2. Use chair-type carrier supports with rectangular steel uprights for accessible urinals.

C. Flushometer-Valve Installation:

1. Install flushometer-valve water-supply fitting on each supply to each urinal.
2. Attach supply piping to supports or substrate within pipe spaces behind fixtures.
3. Install fresh batteries in battery-powered, electronic-sensor mechanisms.

D. Wall Flange and Escutcheon Installation:

1. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations.
2. Install deep-pattern escutcheons if required to conceal protruding fittings.
3. Comply with escutcheon requirements specified in Section 22 05 18 "Escutcheons for Plumbing Piping."

E. Joint Sealing:

1. Seal joints between urinals and walls and floors using sanitary-type, one-part, mildew-resistant silicone sealant.
2. Match sealant color to urinal color.
3. Comply with sealant requirements specified in Section 07 92 00 "Joint Sealants."

3.03 CONNECTIONS

- A. Connect urinals with water supplies and soil, waste, and vent piping. Use size fittings required to match urinals.
- B. Comply with water piping requirements specified in Section 22 11 16 "Domestic Water Piping."
- C. Comply with soil and waste piping requirements specified in Section 22 13 16 "Sanitary Waste and Vent Piping."
- D. Where installing piping adjacent to urinals, allow space for service and maintenance.

3.04 ADJUSTING

- A. Operate and adjust urinals and controls. Replace damaged and malfunctioning urinals, fittings, and controls.
- B. Adjust water pressure at flushometer valves to produce proper flow.

3.05 CLEANING AND PROTECTION

- A. Clean urinals and fittings with manufacturers' recommended cleaning methods and materials.
- B. Install protective covering for installed urinals and fittings.
- C. Do not allow use of urinals for temporary facilities unless approved in writing by Owner.

END OF SECTION 22 42 13.16

SECTION 22 42 16.13
COMMERCIAL LAVATORIES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Lavatories.
2. Faucets.

1.02 SUBMITTALS

A. Product Data: For each type of product.

B. LEED Submittals:

1. Product Data for Prerequisite WE 1, Credit WE 2, and Credit WE 3: Documentation indicating flow and water consumption requirements.

C. Shop Drawings: Include diagrams for power, signal, and control wiring of automatic faucets.

D. Operation and Maintenance Data: For lavatories and faucets to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.01 VITREOUS-CHINA, COUNTER-MOUNTED LAVATORIES

A. Lavatory (L-1): Oval, self rimming, vitreous china, counter mounted.

1. Fixture:

- a. Standard: ASME A112.19.2/CSA B45.1.
- b. Type: Self-rimming for above-counter mounting.
- c. Nominal Size: Oval, 20 by 17 inches (508 by 432 mm).
- d. Faucet-Hole Punching: One hole.
- e. Faucet-Hole Location: Top.
- f. Color: White.
- g. Mounting Material: Sealant.

2. Faucet: Combination mixing sensor operated as scheduled on drawings.

2.02 SUPPLY FITTINGS

- A. NSF Standard: Comply with NSF/ANSI 61, "Drinking Water System Components - Health Effects," for supply-fitting materials that will be in contact with potable water.
- B. Standard: ASME A112.18.1/CSA B125.1.
- C. Supply Piping: Chrome-plated-brass pipe or chrome-plated copper tube matching water-supply piping size. Include chrome-plated-brass or stainless-steel wall flange.
- D. Supply Stops: Chrome-plated-brass, one-quarter-turn, ball-type or compression valve with inlet connection matching supply piping.
- E. Operation: Loose key.
- F. Risers:
 - 1. NPS 3/8 (DN 10).
 - 2. Chrome-plated, soft-copper flexible tube or ASME A112.18.6, braided- or corrugated-stainless-steel, flexible hose riser.

2.03 WASTE FITTINGS

- A. Standard: ASME A112.18.2/CSA B125.2.
- B. Drain: Grid type with NPS 1-1/4 (DN 32) offset and straight tailpiece.
- C. Trap:
 - 1. Size: NPS 1-1/4 (DN 32).
 - 2. Material: Chrome-plated, two-piece, cast-brass trap and swivel elbow with 0.032-inch- (0.83-mm-) thick brass tube to wall or two-piece, cast-brass trap and ground-joint swivel elbow with 0.032-inch- (0.83-mm-) thick brass tube to wall; and chrome-plated, brass or steel wall flange.
 - 3. Material: Stainless-steel, two-piece trap and swivel elbow with 0.012-inch- (0.30-mm-) thick stainless-steel tube to wall; and stainless-steel wall flange.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before lavatory installation.
- B. Examine counters and walls for suitable conditions where lavatories will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install lavatories level and plumb according to roughing-in drawings.
- B. Install supports, affixed to building substrate, for wall-mounted lavatories.
- C. Install accessible wall-mounted lavatories at handicapped/elderly mounting height for people with disabilities or the elderly, according to ICC/ANSI A117.1.
- D. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 22 05 18 "Escutcheons for Plumbing Piping."
- E. Seal joints between lavatories and counters and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 07 92 00 "Joint Sealants."
- F. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible lavatories. Comply with requirements in Section 22 07 19 "Plumbing Piping Insulation."

3.03 CONNECTIONS

- A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- B. Comply with water piping requirements specified in Section 22 11 16 "Domestic Water Piping."
- C. Comply with soil and waste piping requirements specified in Section 22 13 16 "Sanitary Waste and Vent Piping."

3.04 ADJUSTING

- A. Operate and adjust lavatories and controls. Replace damaged and malfunctioning lavatories, fittings, and controls.
- B. Adjust water pressure at faucets to produce proper flow.
- C. Install fresh batteries in battery-powered, electronic-sensor mechanisms.

3.05 CLEANING AND PROTECTION

- A. After completing installation of lavatories, inspect and repair damaged finishes.
- B. Clean lavatories, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.
- C. Provide protective covering for installed lavatories and fittings.

D. Do not allow use of lavatories for temporary facilities unless approved in writing by Owner.

END OF SECTION 22 42 16.13

SECTION 22 42 16.16**COMMERCIAL SINKS**

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section Includes:
 - 1. Service basins.
 - 2. Service sinks.
 - 3. Utility sinks.
 - 4. Sink faucets.
 - 5. Laminar-flow, faucet-spout outlets.
 - 6. Supply fittings.
 - 7. Waste fittings.

1.03 SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for sinks.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. LEED Submittals:
 - 1. Product Data for Prerequisite WE 1, Credit WE 2, and Credit WE 3: Documentation indicating flow and water consumption requirements.
- C. Maintenance Data: For sinks to include in maintenance manuals.

PART 2 - PRODUCTS

2.01 MOP SINKS

- A. Mop Sink (MS-1): Molded stone or cast polymer, floor mounted.
 - 1. Fixture:

- a. Standard: IAPMO PS 99.
 - b. Shape: Rectangular.
 - c. Nominal Size: 24 by 36 inches (610 by 915 mm)]
 - d. Height: 12 inches (305 mm).
 - e. Tiling Flange: Not required.
 - f. Rim Guard: On all top surfaces.
 - g. Drain: Grid with NPS 3 (DN 80) outlet.
2. Mounting: On floor and flush to wall.
 3. Faucet: Wall mounted service sink type faucet with support bracket, pail hook, spout hose. Provide individual wall mounted mop support.

2.02 BREAK ROOM SINK

A. Sink (S-1): Stainless steel, counter mounted with sealant.

1. Fixture: As scheduled on drawings
 - a. Standard: ASME A112.19.3/CSA B45.4.
 - b. Type: counter mounted.
 - c. Number of Compartments: One.
 - d. Metal Thickness: 0.050 inch (1.3 mm).
 - e. Compartment:
 - 1) Drain: Grid with NPS 1-1/2 (DN 40) tailpiece and twist drain.
 - 2) Drain Location: Centered in compartment.
2. Faucet: As scheduled on drawings.
3. Supply Fittings:
 - a. Standard: ASME A112.18.1/CSA B125.1.
 - b. Supplies: Chrome-plated brass compression stop with inlet connection matching water-supply piping type and size.
 - 1) Operation: Wheel handle.
 - 2) Risers: NPS 1/2 (DN 15), chrome-plated, soft-copper flexible tube or ASME A112.18.6, braided or corrugated stainless-steel flexible hose.
4. Waste Fittings:
 - a. Standard: ASME A112.18.2/CSA B125.2.
 - b. Trap(s):
 - 1) Size: NPS 1-1/2 (DN 40).
 - 2) Material: Chrome-plated, two-piece, cast-brass trap and swivel elbow with 0.032-inch- (0.83-mm-) thick brass tube to wall or two-piece, cast-brass trap and ground-joint swivel elbow with 0.032-inch- (0.83-mm-); and chrome-plated brass or steel wall flange.
 - 3) Material: Stainless-steel, two-piece trap and swivel elbow with 0.012-inch- (0.30-mm-) thick stainless-steel tube to wall; and stainless-steel wall flange.
 - c. Continuous Waste:
 - 1) Size: NPS 1-1/2 (DN 40).
 - 2) Material: Chrome-plated, 0.032-inch- (0.83-mm-) thick brass tube.

2.03 GROUT

- A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- B. Characteristics: Nonshrink; recommended for interior and exterior applications.
- C. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before sink installation.
- B. Examine walls, floors, and counters for suitable conditions where sinks will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install sinks level and plumb according to roughing-in drawings.
- B. Set floor-mounted sinks in leveling bed of cement grout.
- C. Install water-supply piping with stop on each supply to each sink faucet.
 - 1. Exception: Use ball or globe valves if supply stops are not specified with sink. Comply with valve requirements specified in Section 22 05 23 "General-Duty Valves for Plumbing Piping."
 - 2. Install stops in locations where they can be easily reached for operation.
- D. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 22 05 18 "Escutcheons for Plumbing Piping."
- E. Seal joints between sinks and counters, floors, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 07 92 00 "Joint Sealants."
- F. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible sinks. Comply with requirements in Section 22 07 19 "Plumbing Piping Insulation."

3.03 CONNECTIONS

- A. Connect sinks with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- B. Comply with water piping requirements specified in Section 22 11 16 "Domestic Water Piping."
- C. Comply with soil and waste piping requirements specified in Section 22 13 16 "Sanitary Waste and Vent Piping."

3.04 ADJUSTING

- A. Operate and adjust sinks and controls. Replace damaged and malfunctioning sinks, fittings, and controls.
- B. Adjust water pressure at faucets to produce proper flow.

3.05 CLEANING AND PROTECTION

- A. After completing installation of sinks, inspect and repair damaged finishes.
- B. Clean sinks, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.
- C. Provide protective covering for installed sinks and fittings.
- D. Do not allow use of sinks for temporary facilities unless approved in writing by Owner.

END OF SECTION 22 42 16.16

SECTION 22 42 23
COMMERCIAL SHOWERS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Individual showers.
 - 2. Shower faucets.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. LEED Submittals:
 - 1. Product Data for Prerequisite WE 1, Credit WE 2, and Credit WE 3: Documentation indicating flow and water consumption requirements.

1.03 CLOSEOUT SUBMITTALS

- A. Maintenance data.

PART 2 - PRODUCTS

2.01 INDIVIDUAL SHOWERS

- A. Individual Showers SH-1:
 - 1. General: Basin per Division 10.

2.02 SHOWER FAUCETS

- A. NSF Standard: Comply with NSF 61, "Drinking Water System Components - Health Effects," for shower materials that will be in contact with potable water.
- B. Shower Faucets (SH-1) as scheduled on drawings.

PART 3 - EXECUTION**3.01 INSTALLATION**

- A. Assemble shower components according to manufacturers' written instructions.
- B. Install showers level and plumb according to roughing-in drawings.
- C. Install water-supply piping with stop on each supply to each shower faucet.
 - 1. Exception: Use ball valves if supply stops are not specified with shower. Comply with valve requirements specified in Section 22 05 23."
 - 2. Install stops in locations where they can be easily reached for operation.
- D. Install shower flow-control fittings with specified maximum flow rates in shower arms.
- E. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheons requirements specified in Section 22 05 18 "Escutcheons for Plumbing Piping."
- F. Seal joints between showers and floors and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 07 92 00 "Joint Sealants."

3.02 CONNECTIONS

- A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- B. Comply with water piping requirements specified in Section 22 11 16 "Domestic Water Piping."
- C. Comply with traps and soil and waste piping requirements specified in Section 22 13 16 "Sanitary Waste and Vent Piping."

3.03 ADJUSTING

- A. Operate and adjust showers and controls. Replace damaged and malfunctioning showers, fittings, and controls.
- B. Adjust water pressure at faucets to produce proper flow.

3.04 CLEANING AND PROTECTION

- A. After completing installation of showers, inspect and repair damaged finishes.

- B. Clean showers, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.
- C. Provide protective covering for installed fixtures and fittings.
- D. Do not allow use of showers for temporary facilities unless approved in writing by Owner.

END OF SECTION 22 42 23

SECTION 22 45 00
EMERGENCY PLUMBING FIXTURES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Eyewash/Emergency shower combination units.
2. Water-tempering equipment.

1.02 ACTION SUBMITTALS

- A. Product Data:** For each type of product indicated.

1.03 INFORMATIONAL SUBMITTALS

- A. Field quality-control test reports.**

1.04 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.**

1.05 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories:** Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ANSI Standard:** Comply with ANSI Z358.1, "Emergency Eyewash and Shower Equipment."
- C. NSF Standard:** Comply with NSF 61, "Drinking Water System Components - Health Effects," for fixture materials that will be in contact with potable water.

PART 2 - PRODUCTS

2.01 COMBINATION UNITS

- A. Standard, Plumbed Emergency Shower with Eyewash Combination Units, (EWSS):**

1. Piping:
 - a. Material: Galvanized steel or plastic.
 - b. Unit Supply: **NPS 1-1/4 (DN 32)** minimum.
 - c. Unit Drain: Outlet at back or side near bottom.

2. Shower:
 - a. Capacity: Not less than **20 gpm (76 L/min.)** for at least 15 minutes.
 - b. Supply Piping: **NPS 1 (DN 25)** with flow regulator and stay-open control valve.
 - c. Control-Valve Actuator: Pull rod.
 - d. Shower Head: **8-inch- (200-mm-)** minimum diameter, plastic.
 - e. Mounting: Pedestal.

3. Eyewash Unit:
 - a. Capacity: Not less than **0.4 gpm (1.5 L/min.)** for at least 15 minutes.
 - b. Supply Piping: **NPS 1/2 (DN 15)** with flow regulator and stay-open control valve.
 - c. Control-Valve Actuator: Paddle.
 - d. Spray-Head Assembly: Two receptor-mounted spray heads.
 - e. Receptor: Plastic bowl.
 - f. Mounting: Attached shower pedestal.

2.02 WATER-TEMPERING EQUIPMENT

A. Hot- and Cold-Water, Water-Tempering Equipment, MV-1:

1. Description: Factory-fabricated equipment with thermostatic mixing valve.
 - a. Thermostatic Mixing Valve: Designed to provide **85 deg F (29 deg C)** tepid, potable water at emergency plumbing fixtures, to maintain temperature at plus or minus **5 deg F (3 deg C)** throughout required 15-minute test period, and in case of unit failure to continue cold-water flow, with union connections, controls, metal piping, and corrosion-resistant enclosure.
 - b. Supply Connections: For hot and cold water.

PART 3 - EXECUTION

3.01 EMERGENCY PLUMBING FIXTURE INSTALLATION

- A. Assemble emergency plumbing fixture piping, fittings, control valves, and other components.
- B. Install fixtures level and plumb.
- C. Fasten fixtures to substrate.

- D. Install shutoff ball valves in water-supply piping to fixtures. Install valves chained or locked in open position if permitted. Install valves in locations where they can easily be reached for operation. Comply with requirements for valves specified in Section 22 05 23.
- E.
 - 1. Exception: Omit shutoff valve on supply to emergency equipment if prohibited by authorities having jurisdiction.
- F. Install dielectric fitting in supply piping to emergency equipment if piping and equipment connections are made of different metals. Comply with requirements for dielectric fittings specified in Section 22 11 16 "Domestic Water Piping."
- G. Install thermometers in supply and outlet piping connections to water-tempering equipment. Comply with requirements for thermometers specified in Section 22 05 19 "Meters and Gages for Plumbing Piping."
- H. Install escutcheons on piping wall and ceiling penetrations in exposed, finished locations. Comply with requirements for escutcheons specified in Section 22 05 18 "Escutcheons for Plumbing Piping."
- I. Fill self-contained fixtures with flushing fluid.

3.02 CONNECTIONS

- A. Connect hot- and cold-water-supply piping to hot- and cold-water, water-tempering equipment. Connect output from water-tempering equipment to emergency plumbing fixtures. Comply with requirements for hot- and cold-water piping specified in Section 22 11 16 "Domestic Water Piping."
- B. Indirectly connect emergency plumbing fixture receptors without trapped drain outlet to sanitary waste or storm drainage piping.
- C. Where installing piping adjacent to emergency plumbing fixtures, allow space for service and maintenance of fixtures.

3.03 IDENTIFICATION

- A. Install equipment nameplates or equipment markers on emergency plumbing fixtures and equipment and equipment signs on water-tempering equipment. Comply with requirements for identification materials specified in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

3.04 FIELD QUALITY CONTROL

- A. Mechanical-Component Testing: After plumbing connections have been made, test for compliance with requirements. Verify ability to achieve indicated capacities.
- B. Tests and Inspections:

1. Perform each visual and mechanical inspection.
 2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation.
 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Emergency plumbing fixtures and water-tempering equipment will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

3.05 ADJUSTING

- A. Adjust or replace fixture flow regulators for proper flow.
- B. Adjust equipment temperature settings.

END OF SECTION 22 45 00

SECTION 22 47 16

PRESSURE WATER COOLERS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes pressure water coolers and related components.

1.02 SUBMITTALS

- A. Product Data: For each type of pressure water cooler.
- B. Shop Drawings: Include diagrams for power, signal, and control wiring.
- C. Maintenance Data: For pressure water coolers to include in maintenance manuals.

PART 2 - PRODUCTS

2.01 PRESSURE WATER COOLERS

- A. Pressure Water Coolers (EWC-1): Wall mounted recessed as scheduled on the drawings.
 - 1. Cabinet: Bi-level with two attached contoured bowls, all stainless steel.
 - 2. Bubbler: One, with adjustable stream regulator, located on each cabinet deck.
 - 3. Control: Push button on front end.
 - 4. Drain: Grid with NPS 1-1/4 (DN 32) tailpiece.
 - 5. Supply: NPS 3/8 (DN 10) with shutoff valve.
 - 6. Waste Fitting: ASME A112.18.2/CSA B125.2, NPS 1-1/4 (DN 32) brass P-trap.
 - 7. Filter: One or more water filters complying with NSF 42 and NSF 53 for cyst and lead reduction to below EPA standards; with capacity sized for unit peak flow rate.
 - 8. Cooling System: Electric, with hermetically sealed compressor, cooling coil, air-cooled condensing unit, corrosion-resistant tubing, refrigerant, corrosion-resistant-metal storage tank, and adjustable thermostat.
 - a. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 9. Capacities and Characteristics:
 - a. Cooled Water: 8 gph (0.0084 L/s)
 - b. Ambient-Air Temperature: 90 deg F (32 deg C).
 - c. Inlet-Water Temperature: 80 deg F (27 deg C).
 - d. Cooled-Water Temperature: 50 deg F (10 deg C).

e. Electrical Characteristics:

- 1) Motor Horsepower: 370 watts.
- 2) Volts: 120-V ac.
- 3) Phase: Single.
- 4) Hertz: 60.
- 5) Full-Load Amperes: 4.0.

10. Support: ASME A112.6.1M, Type I water-cooler carrier.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine roughing-in for water-supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before fixture installation.
- B. Examine walls and floors for suitable conditions where fixtures will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install fixtures level and plumb according to roughing-in drawings. For fixtures indicated for children, install at height required by authorities having jurisdiction.
- B. Install off-the-floor carrier supports, affixed to building substrate, for wall-mounted fixtures.
- C. Install water-supply piping with shutoff valve on supply to each fixture to be connected to domestic-water distribution piping. Use ball or globe valve. Install valves in locations where they can be easily reached for operation. Valves are specified in Section 22 05 23 "General-Duty Valves for Plumbing Piping."
- D. Install trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.
- E. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons where required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 22 05 18 "Escutcheons for Plumbing Piping."
- F. Seal joints between fixtures and walls using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 07 92 00 "Joint Sealants."

3.03 CONNECTIONS

- A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- B. Comply with water piping requirements specified in Section 22 11 16 "Domestic Water Piping."
- C. Install ball or globe shutoff valve on water supply to each fixture. Comply with valve requirements specified in Section 22 05 23 "General-Duty Valves for Plumbing Piping."
- D. Comply with soil and waste piping requirements specified in Section 22 13 16 "Sanitary Waste and Vent Piping."

3.04 ADJUSTING

- A. Adjust fixture flow regulators for proper flow and stream height.
- B. Adjust pressure water-cooler temperature settings.

3.05 CLEANING

- A. After installing fixture, inspect unit. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.
- B. Clean fixtures, on completion of installation, according to manufacturer's written instructions.
- C. Provide protective covering for installed fixtures.
- D. Do not allow use of fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 22 47 16

SECTION 23 05 13**COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT**

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.02 COORDINATION

- A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
 - 1. Motor controllers.
 - 2. Torque, speed, and horsepower requirements of the load.
 - 3. Ratings and characteristics of supply circuit and required control sequence.
 - 4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.01 GENERAL MOTOR REQUIREMENTS

- A. Comply with NEMA MG 1 unless otherwise indicated.

2.02 MOTOR CHARACTERISTICS

- A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet (1000 m) above sea level.
- B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.03 POLYPHASE MOTORS

- A. Description: NEMA MG 1, Design B, medium induction motor.
- B. Efficiency: Energy efficient, as defined in NEMA MG 1.

- C. Service Factor: 1.15.
- D. Multispeed Motors: Variable torque.
 - 1. For motors with 2:1 speed ratio, consequent pole, single winding.
 - 2. For motors with other than 2:1 speed ratio, separate winding for each speed.
- E. Rotor: Random-wound, squirrel cage.
- F. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
- G. Temperature Rise: Match insulation rating.
- H. Insulation: Class F.
- I. Code Letter Designation:
 - 1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
 - 2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.
- J. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.04 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

- A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
- B. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
 - 1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
 - 2. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
 - 3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
 - 4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

2.05 SINGLE-PHASE MOTORS

- A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
 - 1. Permanent-split capacitor.
 - 2. Split phase.
 - 3. Capacitor start, inductor run.
 - 4. Capacitor start, capacitor run.

- B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
- C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
- D. Motors 1/20 HP and Smaller: Shaded-pole type.
- E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 23 05 13

SECTION 23 05 29**HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT****PART 1 - GENERAL****1.01 SUMMARY**

- A. Section Includes:
1. Metal pipe hangers and supports.
 2. Fastener systems.
 3. Equipment supports.

1.02 SUBMITTALS

- A. Product Data: For each type of product indicated or to be used.
- B. Welding certificates.

1.03 QUALITY ASSURANCE

- A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS**2.01 METAL PIPE HANGERS AND SUPPORTS**

- A. Carbon-Steel Pipe Hangers and Supports:
1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
 2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
 3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
 4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
 5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
- B. Stainless-Steel Pipe Hangers and Supports:
1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
 2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.

3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

C. Copper Pipe Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel or stainless steel.

2.02 FASTENER SYSTEMS

- A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
- B. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated or stainless steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.03 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.04 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.
- B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
 1. Properties: Nonstaining, noncorrosive, and nongaseous.
 2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

PART 3 - EXECUTION

3.01 HANGER AND SUPPORT INSTALLATION

- A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
- B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
 2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- C. Fastener System Installation:
1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches (100 mm) thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
 2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- D. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- E. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- F. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- G. Install lateral bracing with pipe hangers and supports to prevent swaying.
- H. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 (DN 65) and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- I. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- J. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
- K. Insulated Piping:
1. Attach clamps and spacers to piping.
 - a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
 - b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
 - c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
 2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

- a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.
3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.
4. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2 (DN 8 to DN 90): 12 inches (305 mm) long and 0.048 inch (1.22 mm) thick.
 - b. NPS 4 (DN 100): 12 inches (305 mm) long and 0.06 inch (1.52 mm) thick.
 - c. NPS 5 and NPS 6 (DN 125 and DN 150): 18 inches (457 mm) long and 0.06 inch (1.52 mm) thick.
 - d. NPS 8 to NPS 14 (DN 200 to DN 350): 24 inches (610 mm) long and 0.075 inch (1.91 mm) thick.
5. Pipes NPS 8 (DN 200) and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.02 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make bearing surface smooth.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.03 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 2. Obtain fusion without undercut or overlap.
 3. Remove welding flux immediately.

4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.04 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to **1-1/2 inches (40 mm)**.

3.05 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 1. Apply paint by brush or spray to provide a minimum dry film thickness of **2.0 mils (0.05 mm)**.
- B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 9.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.06 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use carbon-steel pipe hangers and supports and metal trapeze pipe hangers and attachments for general service applications.
- F. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.
- G. Use padded hangers for piping that is subject to scratching.

- H. Use thermal-hanger shield inserts for insulated piping and tubing.
- I. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes **NPS 1/2 to NPS 30 (DN 15 to DN 750)**.
 2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to **1050 deg F (566 deg C)**, pipes **NPS 4 to NPS 24 (DN 100 to DN 600)**, requiring up to **4 inches (100 mm)** of insulation.
 3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes **NPS 3/4 to NPS 36 (DN 20 to DN 900)**, requiring clamp flexibility and up to **4 inches (100 mm)** of insulation.
 4. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes **NPS 1/2 to NPS 8 (DN 15 to DN 200)**.
 5. U-Bolts (MSS Type 24): For support of heavy pipes **NPS 1/2 to NPS 30 (DN 15 to DN 750)**.
 6. Pipe Saddle Supports (MSS Type 36): For support of pipes **NPS 4 to NPS 36 (DN 100 to DN 900)**, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
 7. Pipe Stanchion Saddles (MSS Type 37): For support of pipes **NPS 4 to NPS 36 (DN 100 to DN 900)**, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
 8. Single-Pipe Rolls (MSS Type 41): For suspension of pipes **NPS 1 to NPS 30 (DN 25 to DN 750)**, from two rods if longitudinal movement caused by expansion and contraction might occur.
 9. Complete Pipe Rolls (MSS Type 44): For support of pipes **NPS 2 to NPS 42 (DN 50 to DN 1050)** if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
- J. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers **NPS 3/4 to NPS 24 (DN 24 to DN 600)**.
 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers **NPS 3/4 to NPS 24 (DN 20 to DN 600)** if longer ends are required for riser clamps.
- K. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to **6 inches (150 mm)** for heavy loads.
 2. Steel Clevises (MSS Type 14): For **120 to 450 deg F (49 to 232 deg C)** piping installations.
- L. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.

2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joint construction, to attach to top flange of structural shape.
 3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 6. C-Clamps (MSS Type 23): For structural shapes.
 7. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lb (340 kg).
 - b. Medium (MSS Type 32): 1500 lb (680 kg).
 - c. Heavy (MSS Type 33): 3000 lb (1360 kg).
 8. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
 9. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
- M. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- N. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- O. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION 23 05 29

SECTION 23 05 93**TESTING, ADJUSTING, AND BALANCING FOR HVAC**

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Balancing Air Systems:
 - a. Constant-volume air systems.

1.02 DEFINITIONS

- A. AABC: Associated Air Balance Council.
- B. NEBB: National Environmental Balancing Bureau.
- C. TAB: Testing, adjusting, and balancing.
- D. TABB: Testing, Adjusting, and Balancing Bureau.
- E. TAB Specialist: An entity engaged to perform TAB Work.

1.03 SUBMITTALS

- A. Certified TAB reports.

1.04 QUALITY ASSURANCE

- A. TAB Contractor Qualifications: Engage a TAB entity certified by AABC, NEBB or TABB.
 - 1. TAB Field Supervisor: Employee of the TAB contractor and certified by AABC, NEBB or TABB
 - 2. TAB Technician: Employee of the TAB contractor and who is certified by AABC, NEBB or TABB as a TAB technician.
- B. Certify TAB field data reports and perform the following:
 - 1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
 - 2. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.
- C. TAB Report Forms: Use standard TAB contractor's forms

- D. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."
- E. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."
- F. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.7.2.3 - "System Balancing."

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.
- B. Examine systems for installed balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are accessible.
- C. Examine the approved submittals for HVAC systems and equipment.
- D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.
- E. Examine equipment performance data including fan curves.
 - 1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
 - 2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.
- F. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.
- G. Examine test reports specified in individual system and equipment Sections.
- H. Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

- I. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- J. Examine operating safety interlocks and controls on HVAC equipment.
- K. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.02 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance", NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" or SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing" and in this Section.
- B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.
 - 1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
 - 2. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Section 23 07 13 "Duct Insulation," Section 23 07 16 "HVAC Equipment Insulation," Section 23 07 19 "HVAC Piping Insulation."
- C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.
- D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.03 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.
- B. Prepare schematic diagrams of systems' "as-built" duct layouts.
- C. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.
- D. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.
- E. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- F. Verify that motor starters are equipped with properly sized thermal protection.

- G. Check dampers for proper position to achieve desired airflow path.
- H. Check for airflow blockages.
- I. Check condensate drains for proper connections and functioning.
- J. Check for proper sealing of air-handling-unit components.
- K. Verify that air duct system is sealed as specified in Section 23 31 13 "Metal Ducts."

3.04 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

- A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
 - 1. Measure total airflow.
 - a. Where sufficient space in ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow.
 - 2. Measure fan static pressures as follows to determine actual static pressure:
 - a. Measure outlet static pressure as far downstream from the fan as practical and upstream from restrictions in ducts such as elbows and transitions.
 - b. Measure static pressure directly at the fan outlet or through the flexible connection.
 - c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from the flexible connection, and downstream from duct restrictions.
 - d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.
 - 3. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.
 - a. Report the cleanliness status of filters and the time static pressures are measured.
 - 4. Measure static pressures entering and leaving other devices, such as sound traps, heat-recovery equipment, and air washers, under final balanced conditions.
 - 5. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
 - 6. Obtain approval from Engineer for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
 - 7. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.

- B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.
 - 1. Measure airflow of submain and branch ducts.
 - a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.
 - 2. Measure static pressure at a point downstream from the balancing damper, and adjust volume dampers until the proper static pressure is achieved.
 - 3. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.

3.05 PROCEDURES FOR MOTORS

- A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:
 - 1. Manufacturer's name, model number, and serial number.
 - 2. Motor horsepower rating.
 - 3. Motor rpm.
 - 4. Efficiency rating.
 - 5. Nameplate and measured voltage, each phase.
 - 6. Nameplate and measured amperage, each phase.
 - 7. Starter thermal-protection-element rating.

3.06 PROCEDURES FOR CONDENSING UNITS

- A. Verify proper rotation of fans.
- B. Measure entering- and leaving-air temperatures.
- C. Record compressor data.

3.07 PROCEDURES FOR HEAT-TRANSFER COILS

- A. Measure, adjust, and record the following data for each electric heating coil:
 - 1. Nameplate data.
 - 2. Airflow.
 - 3. Entering- and leaving-air temperature at full load.
 - 4. Voltage and amperage input of each phase at full load and at each incremental stage.
 - 5. Calculated kilowatt at full load.
 - 6. Fuse or circuit-breaker rating for overload protection.
- B. Measure, adjust, and record the following data for each refrigerant coil:
 - 1. Dry-bulb temperature of entering and leaving air.

2. Wet-bulb temperature of entering and leaving air.
3. Airflow.
4. Air pressure drop.
5. Refrigerant suction pressure and temperature.

3.08 TOLERANCES

- A. Set HVAC system's air flow rates and water flow rates within the following tolerances:
 1. Supply and Exhaust Fans: Plus or minus 10 percent.

3.09 REPORTING

- A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

3.10 FINAL REPORT

- A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
 1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
 2. Include a list of instruments used for procedures, along with proof of calibration.
- B. Final Report Contents: In addition to certified field-report data, include the following
 1. Fan curves.
 2. Manufacturers' test data.
 3. Field test reports prepared by system and equipment installers.
 4. Other information relative to equipment performance; do not include Shop Drawings and product data.
- C. General Report Data: In addition to form titles and entries, include the following data:
 1. Title page.
 2. Name and address of the TAB contractor.
 3. Project name.
 4. Project location.
 5. Architect's name and address.
 6. Engineer's name and address.
 7. Contractor's name and address.
 8. Report date.
 9. Signature of TAB supervisor who certifies the report.
 10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.

11. Summary of contents including the following:
 - a. Indicated versus final performance.
 - b. Notable characteristics of systems.
 - c. Description of system operation sequence if it varies from the Contract Documents.
 12. Nomenclature sheets for each item of equipment.
 13. Data for terminal units, including manufacturer's name, type, size, and fittings.
 14. Notes to explain why certain final data in the body of reports vary from indicated values.
 15. Test conditions for fans and pump performance forms including the following:
 - a. Settings for outdoor-, return-, and exhaust-air dampers.
 - b. Conditions of filters.
 - c. Cooling coil, wet- and dry-bulb conditions.
 - d. Fan drive settings including settings and percentage of maximum pitch diameter.
 - e. Other system operating conditions that affect performance.
- D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
1. Quantities of outdoor, supply, return, and exhaust airflows.
 2. Duct, outlet, and inlet sizes.
 3. Position of balancing devices.

3.11 ADDITIONAL TESTS

- A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.
- B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION 23 05 93

SECTION 23 07 13
DUCT INSULATION**PART 1 - GENERAL****1.01 SUMMARY**

- A. Section includes insulating the following duct services:
 - 1. Indoor, supply, return and outdoor air.

1.02 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Field quality-control reports.

1.03 QUALITY ASSURANCE

- A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

PART 2 - PRODUCTS**2.01 INSULATION MATERIALS**

- A. Comply with requirements in "Duct Insulation Schedules.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

- F. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type II with factory-applied vinyl jacket or Type III with factory-applied FSK jacket . Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
- G. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory-applied ASJ or with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.02 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
- B. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
 - 1. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 2. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- C. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
 - 1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 2. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.03 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
 - 1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below ambient services.
 - 1. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, **0.013 perm** at **43-mil** dry film thickness.
 - 2. Service Temperature Range: **Minus 20 to plus 180 deg F**.
 - 3. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
 - 4. Color: White.

- C. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
1. Water-Vapor Permeance: ASTM F 1249, **1.8 perms** at **0.0625-inch** dry film thickness.
 2. Service Temperature Range: **Minus 20 to plus 180 deg F.**
 3. Solids Content: 60 percent by volume and 66 percent by weight.
 4. Color: White.

2.04 SEALANTS

A. FSK Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: **Minus 40 to plus 250 deg F.**
4. Color: Aluminum.
5. For indoor applications, use sealants that have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
6. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. ASJ Flashing Sealants, and Vinyl Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: **Minus 40 to plus 250 deg F.**
4. Color: White.
5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
6. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.05 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
 2. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
 3. Vinyl Jacket: White vinyl with a permeance of **1.3 perms** when tested according to ASTM E 96/E 96M, Procedure A, and complying with NFPA 90A and NFPA 90B.

2.06 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
1. Width: **3 inches**.
 2. Thickness: **11.5 mils**.
 3. Adhesion: **90 ounces force/inch** in width.
 4. Elongation: 2 percent.
 5. Tensile Strength: **40 lbf/inch** in width.
 6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
1. Width: **3 inches**.
 2. Thickness: **6.5 mils**.
 3. Adhesion: **90 ounces force/inch** in width.
 4. Elongation: 2 percent.
 5. Tensile Strength: **40 lbf/inch** in width.
 6. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

2.07 SECUREMENTS

- A. Insulation Pins and Hangers:
1. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 - a. Baseplate: Perforated, galvanized carbon-steel sheet, **0.030 inch** thick by **2 inches** square.
 - b. Spindle: Aluminum or Stainless steel, fully annealed, **0.106-inch**-diameter shank, length to suit depth of insulation indicated.
 - c. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
 2. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 - a. Baseplate: Perforated, nylon sheet, **0.030 inch** thick by **1-1/2 inches** in diameter.
 - b. Spindle: Nylon, **0.106-inch**-diameter shank, length to suit depth of insulation indicated, up to **2-1/2 inches**.
 - c. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
 3. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position

indicated when self-locking washer is in place. Comply with the following requirements:

- a. Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
 - b. Spindle: Aluminum or Stainless steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
 - c. Adhesive-backed base with a peel-off protective cover.
4. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
- a. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.
5. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- (0.41-mm-) thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
- B. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.
- C. Wire: 0.062-inch soft-annealed, galvanized steel.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.02 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.
- B. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Keep insulation materials dry during application and finishing.

- G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- H. Install insulation with least number of joints practical.
- I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
- J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- K. Install insulation with factory-applied jackets as follows:
 - 1. Draw jacket tight and smooth.
 - 2. Cover circumferential joints with **3-inch**-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced **4 inches** o.c.
 - 3. Overlap jacket longitudinal seams at least **1-1/2 inches**. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
 - a. For below ambient services, apply vapor-barrier mastic over staples.
 - 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
 - 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.
- L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least **4 inches** beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.03 PENETRATIONS

- A. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

- B. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least **2 inches**.
1. Comply with requirements in Section 07 84 13 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

3.04 INSTALLATION OF MINERAL-FIBER INSULATION

- A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
 2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
 3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
 - a. On duct sides with dimensions **18 inches** and smaller, place pins along longitudinal centerline of duct. Space **3 inches** maximum from insulation end joints, and **16 inches** o.c.
 - b. On duct sides with dimensions larger than **18 inches**, place pins **16 inches** o.c. each way, and **3 inches** maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
 - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - d. Do not overcompress insulation during installation.
 - e. Impale insulation over pins and attach speed washers.
 - f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
 4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing **2 inches** from one edge and one end of insulation segment. Secure laps to adjacent insulation section with **1/2-inch** outward-clinching staples, **1 inch** o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
 - a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
 - b. Install vapor stops for ductwork and plenums operating below **50 deg F** at **18-foot (5.5-m)** intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than **3 inches**.

5. Overlap unfaced blankets a minimum of **2 inches** on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of **18 inches** o.c.
 6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
 7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with **6-inch-wide** strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced **6 inches** o.c.
- B. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
 2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
 3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
 - a. On duct sides with dimensions **18 inches** and smaller, place pins along longitudinal centerline of duct. Space **3 inches** maximum from insulation end joints, and **16 inches** o.c.
 - b. On duct sides with dimensions larger than **18 inches**, space pins **16 inches** o.c. each way, and **3 inches** maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
 - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - d. Do not overcompress insulation during installation.
 - e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
 4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing **2 inches** from one edge and one end of insulation segment. Secure laps to adjacent insulation section with **1/2-inch** outward-clinching staples, **1 inch** o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
 - a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
 - b. Install vapor stops for ductwork and plenums operating below **50 deg F** at **18-foot** intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than **3 inches**.
 5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as

possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.

6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with **6-inch- (150-mm-)** wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced **6 inches** o.c.

3.05 FINISHES

- A. Insulation with ASJ or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 09 91 23 "Interior Painting."
 1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
 - a. Finish Coat Material: Interior, flat, latex-emulsion size.
- B. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
- C. Do not field paint aluminum or stainless-steel jackets.

3.06 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 1. Inspect ductwork, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location.
- C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.07 DUCT INSULATION SCHEDULE, GENERAL

- A. Plenums and Ducts Requiring Insulation:
 1. Indoor, supply, return and outdoor air.
- B. Items Not Insulated:
 1. Flexible connectors.
 2. Vibration-control devices.
 3. Factory-insulated access panels and doors.

3.08 INSULATION SCHEDULE

- A. Supply, Return and Outdoor Air Duct Insulation: Mineral-fiber blanket or board 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density.

END OF SECTION 23 07 13

SECTION 23 07 19
HVAC PIPING INSULATION

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes insulating the following HVAC piping systems:
 - 1. Refrigerant suction and hot-gas piping for Refrigerant Systems.

1.02 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Field quality-control reports.

1.03 QUALITY ASSURANCE

- A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

PART 2 - PRODUCTS

2.01 INSULATION MATERIALS

- A. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- B. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- C. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- D. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

- E. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.

2.02 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
- B. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.02 PENETRATIONS

- A. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
 - 1. Seal penetrations with flashing sealant.
 - 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 - 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least **2 inches**.
 - 4. Seal jacket to wall flashing with flashing sealant.

3.03 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

- A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- B. Insulation Installation on Pipe Fittings and Elbows:
 - 1. Install mitered sections of pipe insulation.
 - 2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

- C. Insulation Installation on Valves and Pipe Specialties:
1. Install preformed valve covers manufactured of same material as pipe insulation when available.
 2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 3. Install insulation to flanges as specified for flange insulation application.
 4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.04 PIPING INSULATION SCHEDULE

- A. Refrigerant Suction and Hot-Gas Piping: Flexible elastomeric 1 inch thick.

END OF SECTION 23 07 19

SECTION 23 08 00
COMMISSIONING OF HVAC

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes commissioning process requirements for HVAC&R systems, assemblies, and equipment.
- B. Related Sections:
 - 1. Section 01 91 13 "General Commissioning Requirements" for general commissioning process requirements.

1.02 DEFINITIONS

- A. Commissioning Plan: A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.
- B. CxA: Commissioning Authority.
- C. HVAC&R: Heating, Ventilating, Air Conditioning, and Refrigeration.
- D. Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.

1.03 INFORMATIONAL SUBMITTALS

- A. Certificates of readiness.
- B. Certificates of completion of installation, prestart, and startup activities.

1.04 CONTRACTOR'S RESPONSIBILITIES

- A. Perform commissioning tests at the direction of the CxA.
- B. Attend construction phase controls coordination meeting.
- C. Attend testing, adjusting, and balancing review and coordination meeting.
- D. Participate in HVAC&R systems, assemblies, equipment, and component maintenance orientation and inspection as directed by the CxA.
- E. Provide information requested by the CxA for final commissioning documentation.

- F. Provide measuring instruments and logging devices to record test data, and provide data acquisition equipment to record data for the complete range of testing for the required test period.

1.05 CxA'S RESPONSIBILITIES

- A. Provide Project-specific construction checklists and commissioning process test procedures for actual HVAC&R systems, assemblies, equipment, and components to be furnished and installed as part of the construction contract.
- B. Direct commissioning testing.
- C. Verify testing, adjusting, and balancing of Work are complete.
- D. Provide test data, inspection reports, and certificates in Systems Manual.

1.06 COMMISSIONING DOCUMENTATION

- A. Provide the following information to the CxA for inclusion in the commissioning plan:
 - 1. Plan for delivery and review of submittals, systems manuals, and other documents and reports.
 - 2. Identification of installed systems, assemblies, equipment, and components including design changes that occurred during the construction phase.
 - 3. Process and schedule for completing construction checklists and manufacturer's prestart and startup checklists for HVAC&R systems, assemblies, equipment, and components to be verified and tested.
 - 4. Certificate of readiness, signed by the Contractor, certifying that HVAC&R systems, assemblies, equipment, components, and associated controls are ready for testing.
 - 5. Certificate of completion certifying that installation, prestart checks, and startup procedures have been completed.
 - 6. Test and inspection reports and certificates.
 - 7. Corrective action documents.
 - 8. Verification of testing, adjusting, and balancing reports.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.01 TESTING PREPARATION

- A. Certify that HVAC&R systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.

- B. Certify that HVAC&R instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents, and that pretest set points have been recorded.
- C. Certify that testing, adjusting, and balancing procedures have been completed and that testing, adjusting, and balancing reports have been submitted, discrepancies corrected, and corrective work approved.
- D. Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).
- E. Inspect and verify the position of each device and interlock identified on checklists.
- F. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.
- G. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the CxA.

3.02 Testing AND BALANCING VERIFICATION

- A. Prior to performance of testing and balancing Work, provide copies of reports, sample forms, checklists, and certificates to the CxA.
- B. Notify the CxA at least 10 days in advance of testing and balancing Work, and provide access for the CxA to witness testing and balancing Work.
- C. Provide technicians, instrumentation, and tools to verify testing and balancing of HVAC&R systems at the direction of the CxA.
 - 1. The CxA will notify testing and balancing Subcontractor 10 days in advance of the date of field verification. Notice will not include data points to be verified.
 - 2. The testing and balancing Subcontractor shall use the same instruments (by model and serial number) that were used when original data were collected.
 - 3. Failure of an item includes, other than sound, a deviation of more than 10 percent. Failure of more than 10 percent of selected items shall result in rejection of final testing, adjusting, and balancing report. For sound pressure readings, a deviation of 3 dB shall result in rejection of final testing. Variations in background noise must be considered.
 - 4. Remedy the deficiency and notify the CxA so verification of failed portions can be performed.

3.03 GENERAL TESTING REQUIREMENTS

- A. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.
- B. Scope of HVAC&R testing shall include entire HVAC&R installation. Testing shall include measuring capacities and effectiveness of operational and control functions.

- C. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.
- D. The CxA along with the HVAC&R Subcontractor, testing and balancing Subcontractor, and HVAC&R Instrumentation and Control Subcontractor shall prepare detailed testing plans, procedures, and checklists for HVAC&R systems, subsystems, and equipment.
- E. Tests will be performed using design conditions whenever possible.
- F. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the CxA and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.
- G. The CxA may direct that set points be altered when simulating conditions is not practical.
- H. The CxA may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical.
- I. If tests cannot be completed because of a deficiency outside the scope of the HVAC&R system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.
- J. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

3.04 HVAC&R systems, subsystems, and equipment Testing Procedures

- A. HVAC&R Instrumentation and Control System Testing: Field testing plans and testing requirements are specified in Section 23 09 00 "Instrumentation and Control for HVAC" Assist the CxA with preparation of testing plans.
- B. Refrigeration System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of refrigerant compressors and condensers, VRF fan coils, and other refrigeration systems. The CxA shall determine the sequence of testing and testing procedures for each equipment item and pipe section to be tested.
- C. HVAC&R Distribution System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of air distribution systems; special exhaust; and other distribution systems, including HVAC&R terminal equipment and unitary equipment.
- D. Vibration and Sound Tests: Provide technicians, instrumentation, tools, and equipment to test performance of vibration isolation and seismic controls.

END OF SECTION 23 08 00

SECTION 23 09 00
INSTRUMENTATION AND CONTROL FOR HVAC

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes control equipment for HVAC systems and components, including control components for terminal heating and cooling units not supplied with factory-wired controls.
- B. The VRF Controls submitted with the VRF equipment shall interface with the BMS system provided as defined on the drawings and these specifications. Reference Sections 236200 and 238219 for controls supplied with VRF equipment.

1.02 ACTION SUBMITTALS

- A. Product Data: For each control device indicated.
- B. Shop Drawings:
 - 1. Schematic flow diagrams.
 - 2. Power, signal, and control wiring diagrams.
 - 3. Details of control panel faces.
 - 4. Damper schedule.
 - 5. DDC System Hardware: Wiring diagrams, schematic floor plans, and schematic control diagrams.
 - 6. Control System Software: Schematic diagrams, written descriptions, and points list.

1.03 INFORMATIONAL SUBMITTALS

- A. Field quality-control test reports.

1.04 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.
- B. Software and firmware operational documentation.

1.05 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by Johnson Metasys or a compatible equal to KCMO municipal building systems.

2.02 CONTROL SYSTEM

- A. Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, and accessories to control mechanical systems.
- B. Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, accessories, and software connected to distributed controllers operating in multiuser, multitasking environment on token-passing network and programmed to control mechanical systems. An operator workstation permits interface with the network via dynamic color graphics with each mechanical system, building floor plan, and control device depicted by point-and-click graphics.
- C. Control system communication protocol to comply with ASHRAE 135: 2010 – BACnet communication.

2.03 DDC EQUIPMENT

- A. Operator Workstation: PC-based microcomputer with minimum configuration as follows:
 - 1. Motherboard: With 8 integrated USB 2.0 ports, integrated Intel Pro 10/100 (Ethernet), integrated audio, bios, and hardware monitoring.
 - 2. Processor: Intel Core i3 or greater
 - 3. Random-Access Memory: 4 GB.
 - 4. Graphics: Video adapter, minimum [1600 x 1200] pixels
 - 5. Monitor: 19 inches LCD color.
 - 6. Keyboard: QWERTY, 105 keys in ergonomic shape.
 - 7. Hard-Disk Drive: 500 GB.
 - 8. CD-ROM Read/Write Drive
 - 9. Mouse: Three button, optical.
 - 10. Uninterruptible Power Supply: 2 kVa.

11. Operating System: Microsoft Windows 7 Professional with high-speed Internet access.
- B. Control Units: Modular, comprising processor board with programmable, nonvolatile, random-access memory; local operator access and display panel; integral interface equipment; and backup power source.
1. Units monitor or control each I/O point; process information; execute commands from other control units, devices, and operator stations; and download from or upload to operator workstation.
 2. Stand-alone mode control functions operate regardless of network status. Functions include the following:
 - a. Global communications.
 - b. Discrete/digital, analog, and pulse I/O.
 - c. Monitoring, controlling, or addressing data points.
 - d. Software applications, scheduling, and alarm processing.
 - e. Testing and developing control algorithms without disrupting field hardware and controlled environment.
- C. Local Control Units: Modular, comprising processor board with electronically programmable, nonvolatile, read-only memory; and backup power source.
1. Units monitor or control each I/O point, process information, and download from or upload to operator workstation or diagnostic terminal unit.
 2. Stand-alone mode control functions operate regardless of network status. Functions include the following:
 - a. Global communications.
 - b. Discrete/digital, analog, and pulse I/O.
 - c. Monitoring, controlling, or addressing data points.
 3. Local operator interface provides for download from or upload to operator workstation.
- D. I/O Interface: Hardwired inputs and outputs may tie into system through controllers. Protect points so that shorting will cause no damage to controllers.
1. Binary Inputs: Allow monitoring of on-off signals without external power.
 2. Pulse Accumulation Inputs: Accept up to 10 pulses per second.
 3. Analog Inputs: Allow monitoring of low-voltage (0- to 10-V dc), current (4 to 20 mA), or resistance signals.
 4. Binary Outputs: Provide on-off or pulsed low-voltage signal, selectable for normally open or normally closed operation
 5. Analog Outputs: Provide modulating signal, either low voltage (0- to 10-V dc) or current (4 to 20 mA)
 6. Tri-State Outputs: Provide two coordinated binary outputs for control of three-point, floating-type electronic actuators.
 7. Universal I/Os: Provide software selectable binary or analog outputs.
- E. Power Supplies: Transformers with Class 2 current-limiting type or overcurrent protection; limit connected loads to 80 percent of rated capacity. DC power supply shall match output current and voltage requirements and be full-wave rectifier type with the following:

1. Output ripple of 5.0 mV maximum peak to peak.
 2. Combined 1 percent line and load regulation with 100-mic.sec. response time for 50 percent load changes.
 3. Built-in overvoltage and overcurrent protection and be able to withstand 150 percent overload for at least 3 seconds without failure.
- F. Power Line Filtering: Internal or external transient voltage and surge suppression for workstations or controllers with the following:
1. Minimum dielectric strength of 1000 V.
 2. Maximum response time of 10 nanoseconds.
 3. Minimum transverse-mode noise attenuation of 65 dB.
 4. Minimum common-mode noise attenuation of 150 dB at 40 to 100 Hz.

2.04 UNITARY CONTROLLERS

- A. Unitized, capable of stand-alone operation with sufficient memory to support its operating system, database, and programming requirements, and with sufficient I/O capacity for the application.
1. Configuration: Local keypad and display; diagnostic LEDs for power, communication, and processor; wiring termination to terminal strip or card connected with ribbon cable; memory with bios; and 72 hour battery backup.
 2. Operating System: Manage I/O communication to allow distributed controllers to share real and virtual object information and allow central monitoring and alarms. Perform automatic system diagnostics; monitor system and report failures.
 3. Enclosure: Dustproof rated for operation at 32 to 120 deg F (0 to 50 deg C).

2.05 ANALOG CONTROLLERS

- A. Step Controllers: 6- or 10-stage type, with heavy-duty switching rated to handle loads and operated by electric motor.
- B. Electric, Outdoor-Reset Controllers: Remote-bulb or bimetal rod-and-tube type, proportioning action with adjustable throttling range, adjustable set point, scale range minus 10 to plus 70 deg F (minus 23 to plus 21 deg C), and single- or double-pole contacts.
- C. Electronic Controllers: Wheatstone-bridge-amplifier type, in steel enclosure with provision for remote-resistance readjustment. Identify adjustments on controllers, including proportional band and authority.
1. Single controllers can be integral with control motor if provided with accessible control readjustment potentiometer.

2.06 TIME CLOCKS

- A. Seven-day, programming-switch timer with synchronous-timing motor and seven-day dial; continuously charged, nickel-cadmium-battery-driven, eight-hour, power-failure

carryover; multiple-switch trippers; minimum of two and maximum of eight signals per day with two normally open and two normally closed output contacts.

- B. Solid-state, programmable time control with 4 separate programs each with up to 100 on-off operations; 1-second resolution; lithium battery backup; keyboard interface and manual override; individual on-off-auto switches for each program; 365-day calendar with 20 programmable holidays; choice of fail-safe operation for each program; system fault alarm; and communications package allowing networking of time controls and programming from PC.

2.07 ELECTRONIC SENSORS

- A. Description: Vibration and corrosion resistant; for wall, immersion, or duct mounting as required.

- B. Thermistor Temperature Sensors and Transmitters:

1. Accuracy: Plus or minus 0.5 deg F (0.3 deg C) at calibration point.
2. Wire: Twisted, shielded-pair cable.
3. Insertion Elements in Ducts: Single point, 8 inches (200 mm) long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft. (0.84 sq. m).
4. Averaging Elements in Ducts: 36 inches (915 mm) long, flexible; use where prone to temperature stratification or where ducts are larger than 10 sq. ft. (1 sq. m).
5. Insertion Elements for Liquids: Brass or stainless-steel socket with minimum insertion length of 2-1/2 inches (64 mm).
6. Room Sensor Cover Construction: Manufacturer's standard locking covers.
 - a. Set-Point Adjustment: Concealed.
 - b. Set-Point Indication: Exposed.
 - c. Thermometer: Exposed.
 - d. Color: <Insert color from manufacturer's full range.>
7. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.
8. Room Security Sensors: Stainless-steel cover plate with insulated back and security screws.

- C. RTDs and Transmitters:

1. Accuracy: Plus or minus 0.2 percent at calibration point.
2. Wire: Twisted, shielded-pair cable.
3. Insertion Elements in Ducts: Single point, 8 inches (200 mm) long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft. (0.84 sq. m).
4. Averaging Elements in Ducts: 18 inches (460 mm) long, rigid; use where prone to temperature stratification or where ducts are larger than 9 sq. ft. (0.84 sq. m); length as required.
5. Insertion Elements for Liquids: Brass socket with minimum insertion length of 2-1/2 inches (64 mm).
6. Room Sensor Cover Construction: Manufacturer's standard locking covers.
 - a. Set-Point Adjustment: Concealed.

- b. Set-Point Indication: Exposed.
- c. Thermometer: Exposed.
- 7. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.
- 8. Room Security Sensors: Stainless-steel cover plate with insulated back and security screws.

D. Room sensor accessories include the following:

- 1. Insulating Bases: For sensors located on exterior walls.
- 2. Guards: Locking; heavy-duty, transparent plastic; mounted on separate base or Locking, solid metal, ventilated.
- 3. Adjusting Key: As required for calibration and cover screws.

2.08 STATUS SENSORS

- A. Status Inputs for Fans: Differential-pressure switch with pilot-duty rating and with adjustable range of 0- to 5-inch wg (0 to 1240 Pa).
- B. Status Inputs for Pumps: Differential-pressure switch with pilot-duty rating and with adjustable pressure-differential range of 8 to 60 psig (55 to 414 kPa), piped across pump.
- C. Status Inputs for Electric Motors: Comply with ISA 50.00.01, current-sensing fixed- or split-core transformers with self-powered transmitter, adjustable and suitable for 175 percent of rated motor current.
- D. Voltage Transmitter (100- to 600-V ac): Comply with ISA 50.00.01, single-loop, self-powered transmitter, adjustable, with suitable range and 1 percent full-scale accuracy.
- E. Power Monitor: 3-phase type with disconnect/shorting switch assembly, listed voltage and current transformers, with pulse kilowatt hour output and 4- to 20-mA kW output, with maximum 2 percent error at 1.0 power factor and 2.5 percent error at 0.5 power factor.
- F. Current Switches: Self-powered, solid-state with adjustable trip current, selected to match current and system output requirements.
- G. Electronic Valve/Damper Position Indicator: Visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.
- H. Water-Flow Switches: Bellows-actuated mercury or snap-acting type with pilot-duty rating, stainless-steel or bronze paddle, with appropriate range and differential adjustment, in NEMA 250, Type 1 enclosure.

2.09 THERMOSTATS

- A. Electric, solid-state, microcomputer-based room thermostat with remote sensor.
 - 1. Automatic switching from heating to cooling.
 - 2. Preferential rate control to minimize overshoot and deviation from set point.

3. Set up for four separate temperatures per day.
 4. Instant override of set point for continuous or timed period from 1 hour to 31 days.
 5. Short-cycle protection.
 6. Programming based on [weekday, Saturday, and Sunday] [every day of week].
 7. Selection features include degree F or degree C display, 12- or 24-hour clock, keyboard disable, remote sensor, and fan on-auto.
 8. Battery replacement without program loss.
 9. Thermostat display features include the following:
 - a. Time of day.
 - b. Actual room temperature.
 - c. Programmed temperature.
 - d. Programmed time.
 - e. Duration of timed override.
 - f. Day of week.
 - g. System mode indications include "heating," "off," "fan auto," and "fan on."
- B. Low-Voltage, On-Off Thermostats: NEMA DC 3, 24-V, bimetal-operated, mercury-switch type, with adjustable or fixed anticipation heater, concealed set-point adjustment, **55 to 85 deg F (13 to 30 deg C)** set-point range, and **2 deg F (1 deg C)** maximum differential.
- C. Line-Voltage, On-Off-Auto Thermostats: Bimetal-actuated, open contact or bellows-actuated, enclosed, snap-switch or equivalent solid-state type, with heat anticipator; listed for electrical rating; with concealed set-point adjustment, **55 to 85 deg F (13 to 30 deg C)** set-point range, and **2 deg F (1 deg C)** maximum differential.
1. Electric Heating Thermostats: Equip with off position on dial wired to break ungrounded conductors.
 2. Selector Switch: Integral, manual on-off-auto.
- D. Remote-Bulb Thermostats: On-off or modulating type, liquid filled to compensate for changes in ambient temperature; with copper capillary and bulb, unless otherwise indicated.
1. Bulbs in water lines with separate wells of same material as bulb.
 2. Bulbs in air ducts with flanges and shields.
 3. Averaging Elements: Copper tubing with either single- or multiple-unit elements, extended to cover full width of duct or unit; adequately supported.
 4. Scale settings and differential settings are clearly visible and adjustable from front of instrument.
 5. On-Off Thermostat: With precision snap switches and with electrical ratings required by application.
 6. Modulating Thermostats: Construct so complete potentiometer coil and wiper assembly is removable for inspection or replacement without disturbing calibration of instrument.
- E. Fire-Protection Thermostats: Listed and labeled by an NRTL acceptable to authorities having jurisdiction; with fixed or adjustable settings to operate at not less than **75 deg F (24 deg C)** above normal maximum operating temperature, and the following:
1. Reset: Manual.

2. Reset: Automatic, with control circuit arranged to require manual reset at central control panel; with pilot light and reset switch on panel labeled to indicate operation.
- F. Airstream Thermostats: Two-pipe, fully proportional, single-temperature type; with adjustable set point in middle of range, adjustable throttling range, plug-in test fitting or permanent pressure gage, remote bulb, bimetal rod and tube, or averaging element.
- G. Electric, Low-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual- or automatic- reset switch that trips if temperature sensed across any **12 inches (300 mm)** of bulb length is equal to or below set point.
1. Bulb Length: Minimum **20 feet (6 m)**.
 2. Quantity: One thermostat for every **20 sq. ft. (2 sq. m)** of coil surface.
- H. Electric, High-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual- or automatic- reset switch that trips if temperature sensed across any **12 inches (300 mm)** of bulb length is equal to or above set point.
1. Bulb Length: Minimum **20 feet (6 m)**.
 2. Quantity: One thermostat for every **20 sq. ft. (2 sq. m)** of coil surface.

2.10 ACTUATORS

- A. Electronic Actuators: Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
1. Valves: Size for torque required for valve close off at maximum pump differential pressure.
 2. Dampers: Size for running torque calculated as follows:
 - a. Parallel-Blade Damper with Edge Seals: **7 inch-lb/sq. ft. (86.8 kg-cm/sq. m)** of damper.
 - b. Opposed-Blade Damper with Edge Seals: **5 inch-lb/sq. ft. (62 kg-cm/sq. m)** of damper.
 - c. Parallel-Blade Damper without Edge Seals: **4 inch-lb/sq. ft (49.6 kg-cm/sq. m)** of damper.
 - d. Opposed-Blade Damper without Edge Seals: **3 inch-lb/sq. ft. (37.2 kg-cm/sq. m)** of damper.
 - e. Dampers with **2- to 3-Inch wg (500 to 750 Pa)** of Pressure Drop or Face Velocities of **1000 to 2500 fpm (5 to 13 m/s)**: Increase running torque by 1.5.
 - f. Dampers with **3- to 4-Inch wg (750 to 1000 Pa)** of Pressure Drop or Face Velocities of **2500 to 3000 fpm (13 to 15 m/s)**: Increase running torque by 2.0.
 3. Coupling: V-bolt and V-shaped, toothed cradle.
 4. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
 5. Fail-Safe Operation: Mechanical, spring-return mechanism. Provide external, manual gear release on nonspring-return actuators.
 6. Power Requirements (Two-Position Spring Return): 24 -V ac.
 7. Power Requirements (Modulating): Maximum 10 VA at 24-V ac or 8 W at 24-V dc.

8. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
9. Temperature Rating: 0 to 104 deg F (5 to 40 deg C).
10. Run Time: 60 seconds .

2.11 DAMPERS

- A. Dampers: AMCA-rated, opposed-blade design; 0.108-inch- (2.8-mm-) minimum thick, galvanized-steel or 0.125-inch- (3.2-mm-) minimum thick, extruded-aluminum frames with holes for duct mounting; damper blades shall not be less than 0.064-inch- (1.6-mm-) thick galvanized steel with maximum blade width of 8 inches (200 mm) and length of 48 inches (1220 mm).
 1. Secure blades to 1/2-inch- (13-mm-) diameter, zinc-plated axles using zinc-plated hardware, with nylon blade bearings, blade-linkage hardware of zinc-plated steel and brass, ends sealed against spring-stainless-steel blade bearings, and thrust bearings at each end of every blade.
 2. Operating Temperature Range: From minus 40 to plus 200 deg F (minus 40 to plus 93 deg C).
 3. Edge Seals, Standard Pressure Applications: Closed-cell neoprene.
 4. Edge Seals, Low-Leakage Applications: Use inflatable blade edging or replaceable rubber blade seals and spring-loaded stainless-steel side seals, rated for leakage at less than 10 cfm per sq. ft. (50 L/s per sq. m) of damper area, at differential pressure of 4-inch wg (1000 Pa) when damper is held by torque of 50 in. x lbf (5.6 N x m); when tested according to AMCA 500D.

2.12 CONTROL CABLE

- A. Electronic and fiber-optic cables for control wiring are specified in Section 27 15 00 "Communications Horizontal Cabling."

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Verify location of thermostats and other exposed control sensors with Drawings and room details before installation. Install devices 48 inches (1220 mm) above the floor.
 1. Install averaging elements in ducts and plenums in crossing or zigzag pattern.
- B. Install guards on thermostats in the following locations:
 1. Entrances.
 2. Public areas.
 3. Where indicated.
- C. Install automatic dampers according to Section 23 33 00 "Air Duct Accessories."

- D. Install damper motors on outside of duct in warm areas, not in locations exposed to outdoor temperatures.
- E. Install labels and nameplates to identify control components according to Section 23 05 53 "Identification for HVAC Piping and Equipment."
- F. Install refrigerant instrument wells, valves, and other accessories according to Section 23 23 00 "Refrigerant Piping."
- G. Install duct volume-control dampers according to Section 23 31 13 "Metal Ducts" and Section 23 31 16 "Nonmetal Ducts."
- H. Install electronic and fiber-optic cables according to Section 27 15 00 "Communications Horizontal Cabling."

3.02 ELECTRICAL WIRING AND CONNECTION INSTALLATION

- A. Install raceways, boxes, and cabinets according to Section 26 05 33 "Raceways and Boxes for Electrical Systems."
- B. Install building wire and cable according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."
- C. Install signal and communication cable according to Section 27 15 00 "Communications Horizontal Cabling."
 - 1. Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.
 - 2. Install exposed cable in raceway.
 - 3. Install concealed cable in raceway.
 - 4. Install concealed, accessible cable in open plenum; cable must be plenum rated.
 - 5. Bundle and harness multiconductor instrument cable in place of single cables where several cables follow a common path.
 - 6. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
 - 7. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.
 - 8. Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment.
- D. Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.
- E. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.

3.03 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.
- B. Perform the following field tests and inspections and prepare test reports:
 - 1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.
 - 2. Test and adjust controls and safeties.
 - 3. Test calibration of controllers by disconnecting input sensors and stimulating operation with compatible signal generator.
 - 4. Test each point through its full operating range to verify that safety and operating control set points are as required.
 - 5. Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions.
 - 6. Test each system for compliance with sequence of operation.
 - 7. Test software and hardware interlocks.
- C. DDC Verification:
 - 1. Verify that instruments are installed before calibration, testing, and loop or leak checks.
 - 2. Check instruments for proper location and accessibility.
 - 3. Check instrument installation for direction of flow, elevation, orientation, insertion depth, and other applicable considerations.
 - 4. Check instrument tubing for proper fittings, slope, material, and support.
 - 5. Check pressure instruments, piping slope, installation of valve manifold, and self-contained pressure regulators.
 - 6. Check temperature instruments and material and length of sensing elements.
 - 7. Check control valves. Verify that they are in correct direction.
 - 8. Check air-operated dampers. Verify that pressure gages are provided and that proper blade alignment, either parallel or opposed, has been provided.
 - 9. Check DDC system as follows:
 - a. Verify that DDC controller power supply is from emergency power supply, if applicable.
 - b. Verify that wires at control panels are tagged with their service designation and approved tagging system.
 - c. Verify that spare I/O capacity has been provided.
 - d. Verify that DDC controllers are protected from power supply surges.
- D. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

3.04 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC instrumentation and controls. Refer to Section 01 79 00 "Demonstration and Training."

END OF SECTION 23 09 00

SECTION 23 11 23
FACILITY NATURAL-GAS PIPING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
1. Pipes, tubes, and fittings.
 2. Piping specialties.
 3. Piping and tubing joining materials.
 4. Valves.
 5. Pressure regulators.

1.02 PERFORMANCE REQUIREMENTS

- A. Minimum Operating-Pressure Ratings:
1. Piping and Valves: **100 psig (690 kPa)** minimum unless otherwise indicated.
 2. Service Regulators: **100 psig (690 kPa)** minimum unless otherwise indicated.
- B. Natural-Gas System Pressure within Buildings: **0.5 psig (3.45 kPa)** or less.
- C. Natural-Gas System Pressures within Buildings: Two pressure ranges. Primary pressure is more than **0.5 psig (3.45 kPa)** but not more than **2 psig (13.8 kPa)**, and is reduced to secondary pressure of **0.5 psig (3.45 kPa)** or less.
- D. Delegated Design: Design restraints and anchors for natural-gas piping and equipment, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

1.04 INFORMATIONAL SUBMITTALS

- A. Welding certificates.
- B. Field quality-control reports.

1.05 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.06 QUALITY ASSURANCE

- A. Steel Support Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

PART 2 - PRODUCTS

2.01 PIPES, TUBES, AND FITTINGS

- A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
 - 1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
 - 2. Wrought-Steel Welding Fittings: ASTM A 234/A 234M for butt welding and socket welding.
 - 3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
 - 4. Protective Coating for Underground Piping: Factory-applied, three-layer coating of epoxy, adhesive, and PE.
 - a. Joint Cover Kits: Epoxy paint, adhesive, and heat-shrink PE sleeves.
- B. Corrugated, Stainless-Steel Tubing: Comply with ANSI/IAS LC 1.
 - 1. Tubing: ASTM A 240/A 240M, corrugated, Series 300 stainless steel.
 - 2. Coating: PE with flame retardant.
 - a. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1) Flame-Spread Index: 25 or less.
 - 2) Smoke-Developed Index: 50 or less.
 - 3. Fittings: Copper-alloy mechanical fittings with ends made to fit and listed for use with corrugated stainless-steel tubing and capable of metal-to-metal seal without gaskets. Include brazing socket or threaded ends complying with ASME B1.20.1.
 - 4. Striker Plates: Steel, designed to protect tubing from penetrations.
 - 5. Manifolds: Malleable iron or steel with factory-applied protective coating. Threaded connections shall comply with ASME B1.20.1 for pipe inlet and corrugated tubing outlets.
 - 6. Operating-Pressure Rating: 5 psig (34.5 kPa).
- C. Annealed-Temper Copper Tube: Comply with ASTM B 88, Type K (ASTM B 88M, Type A).
 - 1. Copper Fittings: ASME B16.22, wrought copper, and streamlined pattern.

2. Flare Fittings: Comply with ASME B16.26 and SAE J513.
 - a. Copper fittings with long nuts.
 - b. Metal-to-metal compression seal without gasket.
 - c. Dryseal threads complying with ASME B1.20.3.
 3. Protective Coating for Underground Tubing: Factory-applied, extruded PE a minimum of **0.022 inch (0.56 mm)** thick.
- D. PE Pipe: ASTM D 2513, SDR 11.
1. PE Fittings: ASTM D 2683, socket-fusion type or ASTM D 3261, butt-fusion type with dimensions matching PE pipe.
 2. PE Transition Fittings: Factory-fabricated fittings with PE pipe complying with ASTM D 2513, SDR 11; and steel pipe complying with ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
 3. Anodeless Service-Line Risers: Factory fabricated and leak tested.
 - a. Underground Portion: PE pipe complying with ASTM D 2513, SDR 11 inlet.
 - b. Casing: Steel pipe complying with ASTM A 53/A 53M, Schedule 40, black steel, Type E or S, Grade B, with corrosion-protective coating covering. Vent casing aboveground.
 - c. Aboveground Portion: PE transition fitting.
 - d. Outlet shall be threaded or suitable for welded connection.
 - e. Tracer wire connection.
 - f. Ultraviolet shield.
 - g. Stake supports with factory finish to match steel pipe casing or carrier pipe.
 4. Transition Service-Line Risers: Factory fabricated and leak tested.
 - a. Underground Portion: PE pipe complying with ASTM D 2513, SDR 11 inlet connected to steel pipe complying with ASTM A 53/A 53M, Schedule 40, Type E or S, Grade B, with corrosion-protective coating for aboveground outlet.
 - b. Outlet shall be threaded or suitable for welded connection.
 - c. Bridging sleeve over mechanical coupling.
 - d. Factory-connected anode.
 - e. Tracer wire connection.
 - f. Ultraviolet shield.
 - g. Stake supports with factory finish to match steel pipe casing or carrier pipe.

2.02 PIPING SPECIALTIES

- A. Appliance Flexible Connectors:
1. Indoor, Fixed-Appliance Flexible Connectors: Comply with ANSI Z21.24.
 2. Indoor, Movable-Appliance Flexible Connectors: Comply with ANSI Z21.69.
 3. Outdoor, Appliance Flexible Connectors: Comply with ANSI Z21.75.
 4. Corrugated stainless-steel tubing with polymer coating.
 5. Operating-Pressure Rating: **0.5 psig (3.45 kPa)**.
 6. End Fittings: Zinc-coated steel.
 7. Threaded Ends: Comply with ASME B1.20.1.
 8. Maximum Length: **72 inches (1830 mm.)**

- B. Quick-Disconnect Devices: Comply with ANSI Z21.41.
 - 1. Copper-alloy convenience outlet and matching plug connector.
 - 2. Nitrile seals.
 - 3. Hand operated with automatic shutoff when disconnected.
 - 4. For indoor or outdoor applications.
 - 5. Adjustable, retractable restraining cable.

- C. Y-Pattern Strainers:
 - 1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
 - 2. End Connections: Threaded ends for NPS 2 (DN 50) and smaller.
 - 3. Strainer Screen: 60-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
 - 4. CWP Rating: 125 psig (862 kPa).

- D. Weatherproof Vent Cap: Cast- or malleable-iron increaser fitting with corrosion-resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection.

2.03 JOINING MATERIALS

- A. Joint Compound and Tape: Suitable for natural gas.

- B. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

- C. Brazing Filler Metals: Alloy with melting point greater than 1000 deg F (540 deg C) complying with AWS A5.8/A5.8M. Brazing alloys containing more than 0.05 percent phosphorus are prohibited.

2.04 MANUAL GAS SHUTOFF VALVES

- A. See "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles for where each valve type is applied in various services.

- B. General Requirements for Metallic Valves, NPS 2 (DN 50) and Smaller: Comply with ASME B16.33.
 - 1. CWP Rating: 125 psig (862 kPa).
 - 2. Threaded Ends: Comply with ASME B1.20.1.
 - 3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
 - 4. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 - 5. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch (25 mm) and smaller.
 - 6. Service Mark: Valves 1-1/4 inches (32 mm) to NPS 2 (DN 50) shall have initials "WOG" permanently marked on valve body.

- C. Two-Piece, Regular-Port Bronze Ball Valves with Bronze Trim: MSS SP-110.
1. Body: Bronze, complying with ASTM B 584.
 2. Ball: Chrome-plated bronze.
 3. Stem: Bronze; blowout proof.
 4. Seats: Reinforced TFE.
 5. Packing: Threaded-body packnut design with adjustable-stem packing.
 6. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 7. CWP Rating: 600 psig (4140 kPa).
 8. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
 9. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
- D. Bronze Plug Valves: MSS SP-78.
1. Body: Bronze, complying with ASTM B 584.
 2. Plug: Bronze.
 3. Ends: Threaded, socket, as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 4. Operator: Square head or lug type with tamperproof feature where indicated.
 5. Pressure Class: 125 psig (862 kPa).
 6. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
 7. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
- E. PE Ball Valves: Comply with ASME B16.40.
1. Body: PE.
 2. Ball: PE.
 3. Stem: Acetal.
 4. Seats and Seals: Nitrile.
 5. Ends: Plain or fusible to match piping.
 6. CWP Rating: 80 psig (552 kPa).
 7. Operating Temperature: Minus 20 to plus 140 deg F (Minus 29 to plus 60 deg C).
 8. Operator: Nut or flat head for key operation.
 9. Include plastic valve extension.
 10. Include tamperproof locking feature for valves where indicated on Drawings.

2.05 PRESSURE REGULATORS

- A. General Requirements:
1. Single stage and suitable for natural gas.
 2. Steel jacket and corrosion-resistant components.
 3. Elevation compensator.
 4. End Connections: Threaded for regulators NPS 2 (DN 50) and smaller.
- B. Appliance Pressure Regulators: Comply with ANSI Z21.18.
1. Body and Diaphragm Case: Die-cast aluminum.
 2. Springs: Zinc-plated steel; interchangeable.

3. Diaphragm Plate: Zinc-plated steel.
4. Seat Disc: Nitrile rubber.
5. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
6. Factory-Applied Finish: Minimum three-layer polyester and polyurethane paint finish.
7. Regulator may include vent limiting device, instead of vent connection, if approved by authorities having jurisdiction.
8. Maximum Inlet Pressure: 1 psig (6.9 kPa).

2.06 DIELECTRIC UNIONS

A. Dielectric Unions:

1. Description:
 - a. Standard: ASSE 1079.
 - b. Pressure Rating: 125 psig (860 kPa) minimum at 180 deg F (82 deg C).
 - c. End Connections: Solder-joint copper alloy and threaded ferrous.

2.07 LABELING AND IDENTIFYING

- A. Detectable Warning Tape: Acid- and alkali-resistant, PE film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches (150 mm) wide and 4 mils (0.1 mm) thick, continuously inscribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches (750 mm) deep; colored yellow.

PART 3 - EXECUTION

3.01 OUTDOOR PIPING INSTALLATION

- A. Comply with the 2012 International Fuel Gas Code for installation and purging of natural-gas piping.
- B. Install underground, natural-gas piping buried at least 36 inches (900 mm) below finished grade. Comply with requirements in Section 31 20 00 "Earth Moving" for excavating, trenching, and backfilling.
 1. If natural-gas piping is installed less than 36 inches (900 mm) below finished grade, install it in containment conduit.
- C. Install underground, PE, natural-gas piping according to ASTM D 2774.
- D. Steel Piping with Protective Coating:
 1. Apply joint cover kits to pipe after joining to cover, seal, and protect joints.
 2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.
 3. Replace pipe having damaged PE coating with new pipe.

- E. Copper Tubing with Protective Coating:
 - 1. Apply joint cover kits over tubing to cover, seal, and protect joints.
 - 2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.
- F. Install fittings for changes in direction and branch connections.
- G. Install pressure gage downstream from each service regulator.

3.02 INDOOR PIPING INSTALLATION

- A. Comply with the 2012 International Fuel Gas Code for installation and purging of natural-gas piping.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.
- D. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- G. Locate valves for easy access.
- H. Install natural-gas piping at uniform grade of 2 percent down toward drip and sediment traps.
- I. Install piping free of sags and bends.
- J. Install fittings for changes in direction and branch connections.
- K. Verify final equipment locations for roughing-in.
- L. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.
- M. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.

1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches (75 mm) long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.
 - N. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.
 - O. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels unless indicated to be exposed to view.
 - P. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.
 - Q. Connect branch piping from top or side of horizontal piping.
 - R. Install unions in pipes NPS 2 (DN 50) and smaller, adjacent to each valve, at final connection to each piece of equipment.
 - S. Do not use natural-gas piping as grounding electrode.
 - T. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.
 - U. Install pressure gage upstream and downstream from each line regulator.
 - V. Install sleeves for piping penetrations of walls, ceilings, and floors.
 - W. Install sleeve seals for piping penetrations of concrete walls and slabs.
 - X. Install escutcheons for piping penetrations of walls, ceilings, and floors.
- 3.03 VALVE INSTALLATION
- A. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless-steel tubing or copper connector.
 - B. Install underground valves with valve boxes.
 - C. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.
 - D. Install earthquake valves aboveground outside buildings according to listing.
 - E. Install anode for metallic valves in underground PE piping.
- 3.04 PIPING JOINT CONSTRUCTION
- A. Ream ends of pipes and tubes and remove burrs.

- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Threaded Joints:
 - 1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
 - 2. Cut threads full and clean using sharp dies.
 - 3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
 - 4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
 - 5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- D. Welded Joints:
 - 1. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.
 - 2. Bevel plain ends of steel pipe.
 - 3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter.
- F. Flared Joints: Cut tubing with roll cutting tool. Flare tube end with tool to result in flare dimensions complying with SAE J513. Tighten finger tight, then use wrench. Do not overtighten.
- G. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.
 - 1. Plain-End Pipe and Fittings: Use butt fusion.
 - 2. Plain-End Pipe and Socket Fittings: Use socket fusion.

3.05 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements for pipe hangers and supports specified in Section 23 05 29 "Hangers and Supports for HVAC Piping and Equipment."
- B. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:
 - 1. **NPS 1 (DN 25)** and Smaller: Maximum span, **96 inches (2438 mm)**; minimum rod size, **3/8 inch (10 mm)**.
 - 2. **NPS 1-1/4 (DN 32)**: Maximum span, **108 inches (2743 mm)**; minimum rod size, **3/8 inch (10 mm)**.
 - 3. **NPS 1-1/2 and NPS 2 (DN 40 and DN 50)**: Maximum span, **108 inches (2743 mm)**; minimum rod size, **3/8 inch (10 mm)**.

3.06 CONNECTIONS

- A. Connect to utility's gas main according to utility's procedures and requirements.
- B. Install natural-gas piping electrically continuous, and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.
- C. Install piping adjacent to appliances to allow service and maintenance of appliances.
- D. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within **72 inches (1800 mm)** of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.
- E. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

3.07 LABELING AND IDENTIFYING

- A. Install detectable warning tape directly above gas piping, **12 inches (300 mm)** below finished grade, except **6 inches (150 mm)** below subgrade under pavements and slabs.

3.08 FIELD QUALITY CONTROL

- A. Test, inspect, and purge natural gas according to 2012 International Fuel Gas Code and authorities having jurisdiction.
- B. Natural-gas piping will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

3.09 OUTDOOR PIPING SCHEDULE

- A. Underground natural-gas piping shall be one of the following:
 - 1. PE pipe and fittings joined by heat fusion; service-line risers with tracer wire terminated in an accessible location.
 - 2. Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.
 - 3. Annealed-temper copper tube with wrought-copper fittings and brazed joints. Coat pipe and fittings with protective coating for copper tubing.
- B. Aboveground natural-gas piping shall be one of the following:
 - 1. Steel pipe with malleable-iron fittings and threaded joints.
 - 2. Steel pipe with wrought-steel fittings and welded joints.
 - 3. Annealed-temper copper tube with wrought-copper fittings and brazed joints.
- C. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.

3.10 INDOOR PIPING SCHEDULE

- A. Aboveground, branch piping **NPS 1 (DN 25)** and smaller shall be one of the following:
 - 1. Corrugated stainless-steel tubing with mechanical fittings having socket or threaded ends to match adjacent piping.
 - 2. Annealed-temper copper tube with wrought-copper fittings and brazed or flared joints.
 - 3. Steel pipe with malleable-iron fittings and threaded joints.
- B. Aboveground, distribution piping shall be one of the following:
 - 1. Steel pipe with malleable-iron fittings and threaded joints.
 - 2. Steel pipe with wrought-steel fittings and welded joints.
- C. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.
- D. Containment Conduit Vent Piping: Steel pipe with malleable-iron fittings and threaded or wrought-steel fittings with welded joints. Coat underground pipe and fittings with protective coating for steel piping.

3.11 UNDERGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

- A. Connections to Existing Gas Piping: Use valve and fitting assemblies made for tapping utility's gas mains and listed by an NRTL.
- B. Underground: PE or Bronze plug valves.

3.12 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

- A. Valves for pipe sizes **NPS 2 (DN 50)** and smaller shall be one of the following:
 - 1. Two-piece, regular-port, bronze ball valves with bronze trim.
 - 2. Bronze plug valve.

END OF SECTION 23 11 23

SECTION 23 23 00
REFRIGERANT PIPING

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes refrigerant piping used for air-conditioning applications.

1.02 PERFORMANCE REQUIREMENTS

- A. Line Test Pressure for Refrigerant R-410:
1. Suction Lines: 325 psig.
 2. Hot-Gas and Liquid Lines: 325 psig.

1.03 SUBMITTALS

- A. Product Data: For each type of valve and refrigerant piping specialty indicated. Include pressure drop based on manufacturer's test data.
- B. Field quality-control test reports.
- C. Operation and maintenance data.

1.04 QUALITY ASSURANCE

- A. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."
- B. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

1.05 PRODUCT STORAGE AND HANDLING

- A. Store piping in a clean and protected area with end caps in place to ensure that piping interior and exterior are clean when installed.

PART 2 - PRODUCTS

2.01 COPPER TUBE AND FITTINGS

- A. Copper Tube: ASTM B 280, Type ACR.
- B. Wrought-Copper Fittings: ASME B16.22.

- C. Wrought-Copper Unions: ASME B16.22.
- D. Solder Filler Metals: ASTM B 32. Use 95-5 tin antimony or alloy HB solder to join copper socket fittings on copper pipe.
- E. Brazing Filler Metals: AWS A5.8.
- F. Flexible Connectors:
 - 1. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.
 - 2. End Connections: Socket ends.
 - 3. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch- (180-mm-) long assembly.
 - 4. Pressure Rating: Factory test at minimum 500 psig.
 - 5. Maximum Operating Temperature: 250 deg F).

2.02 VALVES AND SPECIALTIES

- A. Check Valves:
 - 1. Body: Ductile iron, forged brass, or cast bronze; globe pattern.
 - 2. Bonnet: Bolted ductile iron, forged brass, or cast bronze; or brass hex plug.
 - 3. Piston: Removable polytetrafluoroethylene seat.
 - 4. Closing Spring: Stainless steel.
 - 5. Manual Opening Stem: Seal cap, plated-steel stem, and graphite seal.
 - 6. End Connections: Socket, union, threaded, or flanged.
 - 7. Maximum Opening Pressure: 0.50 psig.
 - 8. Working Pressure Rating: 500 psig.
 - 9. Maximum Operating Temperature: 275 deg F.
- B. Service Valves:
 - 1. Body: Forged brass with brass cap including key end to remove core.
 - 2. Core: Removable ball-type check valve with stainless-steel spring.
 - 3. Seat: Polytetrafluoroethylene.
 - 4. End Connections: Copper spring.
 - 5. Working Pressure Rating: 500 psig.
- C. Solenoid Valves: Comply with ARI 760 and UL 429; listed and labeled by an NRTL.
 - 1. Body and Bonnet: Plated steel.
 - 2. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
 - 3. Seat: Polytetrafluoroethylene.
 - 4. End Connections: Threaded.
 - 5. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter, and 24-V ac coil.
 - 6. Working Pressure Rating: 400 psig.
 - 7. Maximum Operating Temperature: 240 deg F.
 - 8. Manual operator.

- D. Safety Relief Valves: Comply with ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.
1. Body and Bonnet: Ductile iron and steel, with neoprene O-ring seal.
 2. Piston, Closing Spring, and Seat Insert: Stainless steel.
 3. Seat Disc: Polytetrafluoroethylene.
 4. End Connections: Threaded.
 5. Working Pressure Rating: 400 psig.
 6. Maximum Operating Temperature: 240 deg F.
- E. Thermostatic Expansion Valves: Comply with ARI 750.
1. Body, Bonnet, and Seal Cap: Forged brass or steel.
 2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
 3. Packing and Gaskets: Non-asbestos.
 4. Capillary and Bulb: Copper tubing filled with refrigerant charge.
 5. Suction Temperature: 40 deg F.
 6. Superheat: Adjustable.
 7. Reverse-flow option (for heat-pump applications).
 8. End Connections: Socket, flare, or threaded union.
 9. Working Pressure Rating: 450 psig.
- F. Straight-Type Strainers:
1. Body: Welded steel with corrosion-resistant coating.
 2. Screen: 100-mesh stainless steel.
 3. End Connections: Socket or flare.
 4. Working Pressure Rating: 500 psig.
 5. Maximum Operating Temperature: 275 deg F.
- G. Moisture/Liquid Indicators:
1. Body: Forged brass.
 2. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.
 3. Indicator: Color coded to show moisture content in ppm.
 4. Minimum Moisture Indicator Sensitivity: Indicate moisture above 60 ppm.
 5. End Connections: Socket or flare.
 6. Working Pressure Rating: 500 psig.
 7. Maximum Operating Temperature: 240 deg F
- H. Replaceable-Core Filter Dryers: Comply with ARI 730.
1. Body and Cover: Painted-steel shell with ductile-iron cover, stainless-steel screws, and neoprene gaskets.
 2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
 3. Desiccant Media: Activated alumina or charcoal.
 4. Designed for reverse flow (for heat-pump applications).
 5. End Connections: Socket.
 6. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
 7. Maximum Pressure Loss: 2 psig.
 8. Rated Flow: 5 tons maximum
 9. Working Pressure Rating: 500 psig.

10. Maximum Operating Temperature: 240 deg F).

PART 3 - EXECUTION

3.01 PIPING APPLICATIONS

- A. Refrigerant lines: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed or soldered joints.

3.02 VALVE AND SPECIALTY APPLICATIONS (as required or recommended by equipment manufacturer if not supplied with HVAC equipment.)

- A. Install valves in suction and discharge lines of compressor.
- B. Install service valves for gage taps at strainers if they are not an integral part of strainers.
- C. Install a check valve at the compressor discharge and a liquid accumulator at the compressor suction connection.
- D. Except as otherwise indicated, install valves on inlet and outlet side of filter dryers.
- E. Install a full-sized, three-valve bypass around filter dryers.
- F. Install solenoid valves upstream from each expansion valve. Install solenoid valves in horizontal lines with coil at top.
- G. Install thermostatic expansion valves as close as possible to distributors on evaporators.
1. Install valve so diaphragm case is warmer than bulb.
 2. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line.
 3. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.
- H. Install safety relief valves where required by ASME Boiler and Pressure Vessel Code. Pipe safety-relief-valve discharge line to outside according to ASHRAE 15.
- I. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.
- J. Install strainers upstream from and adjacent to the following unless they are furnished as an integral assembly for device being protected:
1. Solenoid valves.
 2. Thermostatic expansion valves.
 3. Compressor.

- K. Install filter dryers in liquid line between compressor and thermostatic expansion valve, and in the suction line at the compressor.
- L. Install flexible connectors at compressors.

3.03 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems; indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings.
- B. Install refrigerant piping according to ASHRAE 15.
- C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping adjacent to machines to allow service and maintenance.
- F. Install piping free of sags and bends.
- G. Install fittings for changes in direction and branch connections.
- H. Select system components with pressure rating equal to or greater than system operating pressure.
- I. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.
- J. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.
- K. Slope refrigerant piping as follows:
 - 1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
 - 2. Install horizontal suction lines with a uniform slope downward to compressor.
 - 3. Install traps and double risers to entrain oil in vertical runs.
 - 4. Liquid lines may be installed level.
- L. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.
- M. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.

3.04 PIPE JOINT CONSTRUCTION

- A. Soldered Joints: Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook."
- B. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."
 - 1. Use Type BcuP, copper-phosphorus alloy for joining copper socket fittings with copper pipe.
 - 2. Use Type BA_g, cadmium-free silver alloy for joining copper with bronze or steel.

3.05 HANGERS AND SUPPORTS

- A. Install the following pipe attachments:
 - 1. Adjustable steel clevis hangers for individual horizontal runs less than **20 feet** long.
 - 2. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
- B. Install hangers for copper tubing with the following maximum spacing and minimum rod sizes:
 - 1. **NPS 1/2**: Maximum span, **60 inches**; minimum rod size, **1/4 inch**.
 - 2. **NPS 5/8**: Maximum span, **60 inches**; minimum rod size, **1/4 inch**.
 - 3. **NPS 1**: Maximum span, **72 inches**; minimum rod size, **1/4 inch**.
 - 4. **NPS 1-1/4**: Maximum span, **96 inches**; minimum rod size, **3/8 inch**.

3.06 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
- B. Tests and Inspections:
 - 1. Comply with ASME B31.5, Chapter VI.
 - 2. Test refrigerant piping and specialties. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
 - 3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in Part 1 "Performance Requirements" Article.
 - a. Fill system with nitrogen to the required test pressure.
 - b. System shall maintain test pressure at the manifold gage throughout duration of test.
 - c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
 - d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.

3.07 SYSTEM CHARGING

- A. Charge system using the following procedures:
 - 1. Install core in filter dryers after leak test but before evacuation.
 - 2. Evacuate entire refrigerant system with a vacuum pump to **500 micrometers**. If vacuum holds for 12 hours, system is ready for charging.
 - 3. Break vacuum with refrigerant gas, allowing pressure to build up to **2 psig**.
 - 4. Charge system with a new filter-dryer core in charging line.

3.08 ADJUSTING

- A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.
- B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.
- C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.
- D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:
 - 1. Verify that compressor oil level is correct.
 - 2. Open compressor suction and discharge valves.
 - 3. Open refrigerant valves except bypass valves that are used for other purposes.
 - 4. Check open compressor-motor alignment and verify lubrication for motors and bearings.
- E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION 23 23 00

SECTION 23 31 13**METAL DUCTS**

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
1. Rectangular ducts and fittings.
 2. Round ducts and fittings
 3. Sheet metal materials.
 4. Sealants and gaskets.
 5. Hangers and supports.

1.02 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to the following:
1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
 2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports.
 3. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.
- B. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

PART 2 - PRODUCTS

2.01 RECTANGULAR DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.
- B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

- D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.02 ROUND DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.
- B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- D. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.03 SHEET METAL MATERIALS

- A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
- Galvanized Coating Designation: **G90**.
 - Finishes for Surfaces Exposed to View: Mill phosphatized.
- C. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

- D. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.04 SEALANT AND GASKETS

- A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
- B. Two-Part Tape Sealing System:
1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
 2. Tape Width: 4 inches.
 3. Sealant: Modified styrene acrylic.
 4. Water resistant.
 5. Mold and mildew resistant.
 6. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
 7. Service: Indoor and outdoor.
 8. Service Temperature: Minus 40 to plus 200 deg F.
 9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.

2.05 HANGERS AND SUPPORTS

- A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.
- B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
- C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."
- D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.
- E. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.
- F. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- G. Trapeze and Riser Supports:
1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
 2. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

PART 3 - EXECUTION**3.01 DUCT INSTALLATION**

- A. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.
- B. Install ducts with fewest possible joints.
- C. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.
- D. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.
- E. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- F. Install ducts with a clearance of **1 inch**, plus allowance for insulation thickness.
- G. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.
- H. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least **1-1/2 inches**.

3.02 INSTALLATION OF EXPOSED DUCTWORK

- A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.
- B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.
- C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.
- D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.
- E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.03 DUCT SEALING

- A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- B. Seal ducts to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":
 - 1. Conditioned Space, Supply-Air Ducts in Pressure Classes **2-Inch wg** and Lower: Seal Class C.
 - 2. Conditioned Space, Exhaust Ducts: Seal Class B.
 - 3. Conditioned Space, Return-Air Ducts: Seal Class C.

3.04 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."
- B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
 - 1. Where practical, install concrete inserts before placing concrete.
 - 2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
 - 3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than **4 inches** thick.
 - 4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than **4 inches** thick.
 - 5. Do not use powder-actuated concrete fasteners for seismic restraints.
- C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," **Table 5-1**, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within **24 inches** of each elbow and within **48 inches** of each branch intersection.
- D. Hangers Exposed to View: Threaded rod and angle or channel supports.
- E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of **16 feet**).
- F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.05 CONNECTIONS

- A. Make connections to equipment with flexible connectors complying with Section 23 33 00 "Air Duct Accessories."
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.06 START UP

- A. Air Balance: Comply with requirements in Section 23 05 93 "Testing, Adjusting, and Balancing for HVAC."

END OF SECTION 23 31 13

SECTION 23 31 16**NONMETAL DUCTS**

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section Includes:
 - 1. PVC ducts and fittings for underground duct to pits

1.03 PERFORMANCE REQUIREMENTS

- A. Delegated Duct Design: Duct construction, including duct closure, reinforcements, and hangers and supports, shall comply with SMACNA's "Fibrous Glass Duct Construction Standards" and performance requirements and design criteria indicated.
 - 1. Static-Pressure Classes:
 - a. Exhaust Ducts (Negative Pressure): 1-inch wg (250 Pa).
- B. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of the following products:
 - 1. PVC duct materials.
- B. LEED Submittals:
 - 1. Product Data for Prerequisite IEQ 1: Documentation indicating that duct systems comply with ASHRAE 62.1, Section 5 - "Systems and Equipment."
- C. Field quality-control reports.

1.05 QUALITY ASSURANCE

- A. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-up."

PART 2 - PRODUCTS

2.01 PVC DUCTS AND FITTINGS

A. Duct and Fittings:

1. Round Duct: Comply with cell Classification 12454-B in ASTM D 1784, with external loading properties of ASTM D 2412.
2. Round Fittings: Socket end molded of same material, pressure class, and joining method as duct.

B. Joining Materials: PVC solvent cement complying with ASTM D 2564.

1. PVC solvent cement shall have a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Solvent cement and adhesive primer shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Fabrication:

1. Fabricate joints, seams, transitions, reinforcement, elbows, branch connections, and access doors and panels according to SMACNA's "Thermoplastic Duct (PVC) Construction Manual," Chapter 3, "Standards of Construction for PVC Duct Systems."
2. Fabricate 90-degree rectangular mitered elbows to include turning vanes, 90-degree round elbows with a minimum of three segments for 12 inches (300 mm) and smaller and a minimum of five segments for 14 inches (350 mm) and larger.

PART 3 - EXECUTION

3.01 DUCT INSTALLATION

- A. Install ducts with fewest possible joints.
- B. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.
- C. Install ducts with a clearance of 1 inch (25 mm), plus allowance for insulation thickness.
- D. Install PVC ducts and fittings to comply with SMACNA's "Thermoplastic Duct (PVC) Construction Manual."

3.02 FIELD QUALITY CONTROL

- A. Perform tests and inspections.

- B. Leakage Tests:
 - 1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.
 - 2. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
 - 3. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test entire system at maximum system design pressure.
- C. Duct System Cleanliness Tests:
 - 1. Visually inspect duct system to ensure that no visible contaminants are present.
- D. Duct system will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

3.03 START UP

- A. Air Balance: Comply with requirements in Section 23 05 93 "Testing, Adjusting, and Balancing for HVAC."

3.04 DUCT SCHEDULE

- A. Underground Ducts: PVC Round Ducts and Fittings:

END OF SECTION 23 31 16

SECTION 23 33 00
AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
1. Backdraft and pressure relief dampers.
 2. Manual volume dampers.
 3. Control dampers.
 4. Fire dampers.
 5. Flange connectors.
 6. Turning vanes.
 7. Duct-mounted access doors.
 8. Flexible connectors.
 9. Flexible ducts.
 10. Duct accessory hardware.

1.02 SUBMITTALS

- A. Product Data: For each type of product.
- B. Operation and maintenance data.

PART 2 - PRODUCTS

2.01 BACKDRAFT AND PRESSURE RELIEF DAMPERS

- A. Description: Gravity balanced.
- B. Frame: Hat-shaped, 0.05-inch- (1.3-mm-) thick, galvanized sheet steel, with welded corners or mechanically attached and mounting flange.
- C. Blades: Multiple single-piece blades, center pivoted, maximum 6-inch (150-mm) width, 0.025-inch- (0.6-mm-) thick, roll-formed aluminum with sealed edges.
- D. Blade Action: Parallel.
- E. Blade Seals: Extruded vinyl, mechanically locked or Neoprene, mechanically locked.
- F. Blade Axles:
1. Material: Plated steel.
 2. Diameter: 0.20 inch (5 mm).

- G. Tie Bars and Brackets: Aluminum or Galvanized steel.
- H. Return Spring: Adjustable tension.
- I. Bearings: Steel ball or synthetic pivot bushings.
- J. Accessories:
 - 1. Adjustment device to permit setting for varying differential static pressure.
 - 2. Counterweights and spring-assist kits for vertical airflow installations.

2.02 MANUAL VOLUME DAMPERS

- A. Standard, Steel, Manual Volume Dampers:
 - 1. Standard leakage rating, with linkage outside airstream.
 - 2. Suitable for horizontal or vertical applications.
 - 3. Frames:
 - a. Frame: Hat-shaped, 0.094-inch- (2.4-mm-) thick, galvanized sheet steel.
 - b. Mitered and welded corners.
 - c. Flanges for attaching to walls and flangeless frames for installing in ducts.
 - 4. Blades:
 - a. Multiple or single blade.
 - b. Parallel- or opposed-blade design.
 - c. Stiffen damper blades for stability.
 - d. Galvanized-steel, 0.064 inch (1.62 mm) thick.
 - 5. Blade Axles: Galvanized steel.
 - 6. Bearings:
 - a. Oil-impregnated bronze.
 - b. Dampers in ducts with pressure classes of 3-inch wg (750 Pa) or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
 - 7. Tie Bars and Brackets: Galvanized steel.

2.03 CONTROL DAMPERS

- A. Frames:
 - 1. Hat, U or Angle shaped.
 - 2. 0.094-inch- (2.4-mm-) thick, galvanized sheet steel.
 - 3. Mitered and welded or Interlocking, gusseted corners.
- B. Blades:
 - 1. Multiple blade with maximum blade width of 6 inches (152 mm).
 - 2. Parallel- and opposed-blade design.
 - 3. Galvanized-steel. 0.064 inch (1.62 mm) thick single skin or 0.0747-inch- (1.9-mm-) thick dual skin .

4. Blade Edging: Closed-cell neoprene or PVC.
 5. Blade Edging: Inflatable seal blade edging, or replaceable rubber seals.
- C. Blade Axles: **1/2-inch- (13-mm-)** diameter; galvanized steel; blade-linkage hardware of zinc-plated steel and brass; ends sealed against blade bearings.
1. Operating Temperature Range: From **minus 40 to plus 200 deg F (minus 40 to plus 93 deg C)**.
- D. Bearings:
1. Oil-impregnated bronze or Molded synthetic.
 2. Dampers in ducts with pressure classes of **3-inch wg (750 Pa)** or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
 3. Thrust bearings at each end of every blade.

2.04 FIRE DAMPERS

- A. Type: Static; rated and labeled according to UL 555 by an NRTL.
- B. Closing rating in ducts up to **4-inch wg (1-kPa)** static pressure class and minimum **2000-fpm (10-m/s)** velocity.
- C. Fire Rating: 1-1/2 hours.
- D. Frame: Curtain type with blades outside airstream except when located behind grille where blades may be inside airstream]; fabricated with roll-formed, **0.034-inch- (0.85-mm-)** thick galvanized steel; with mitered and interlocking corners.
- E. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.
1. Minimum Thickness: **0.138 inch (3.5 mm)** thick, as indicated, and of length to suit application.
 2. Exception: Omit sleeve where damper-frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame must comply with sleeve requirements.
- F. Mounting Orientation: Vertical or horizontal as indicated.
- G. Blades: Roll-formed, interlocking, **0.034-inch- (0.85-mm-)** thick, galvanized sheet steel. In place of interlocking blades, use full-length, **0.034-inch- (0.85-mm-)** thick, galvanized-steel blade connectors.
- H. Horizontal Dampers: Include blade lock and stainless-steel closure spring.
- I. Heat-Responsive Device: Replaceable, **165 deg F (74 deg C)** rated, fusible links.

2.05 FLANGE CONNECTORS

- A. Description: Add-on or roll-formed, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.

- B. Material: Galvanized steel.
- C. Gage and Shape: Match connecting ductwork.

2.06 TURNING VANES

- A. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
 - 1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.
- B. Manufactured Turning Vanes for Nonmetal Ducts: Fabricate curved blades of resin-bonded fiberglass with acrylic polymer coating; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
- C. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 4-3, "Vaness and Vane Runners," and 4-4, "Vane Support in Elbows."
- D. Vane Construction: Single wall.

2.07 DUCT-MOUNTED ACCESS DOORS

- A. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 7-2 (7-2M), "Duct Access Doors and Panels," and 7-3, "Access Doors - Round Duct."
 - 1. Door:
 - a. Double wall, rectangular.
 - b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
 - c. Vision panel.
 - d. Hinges and Latches: 1-by-1-inch (25-by-25-mm) butt or piano hinge and cam latches.
 - e. Fabricate doors airtight and suitable for duct pressure class.
 - 2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
 - 3. Number of Hinges and Locks:
 - a. Access Doors Less Than 12 Inches (300 mm) Square: No hinges and two sash locks.
 - b. Access Doors up to 18 Inches (460 mm) Square: Continuous and two sash locks.
 - c. Access Doors up to 24 by 48 Inches (600 by 1200 mm): Continuous and two compression latches with outside and inside handles.
 - d. Access Doors Larger Than 24 by 48 Inches (600 by 1200 mm): Continuous and two compression latches with outside and inside handles.

2.08 DUCT ACCESS PANEL ASSEMBLIES

- A. Labeled according to UL 1978 by an NRTL.
- B. Panel and Frame: Minimum thickness 0.0528-inch (1.3-mm) carbon steel.
- C. Fasteners: Carbon steel. Panel fasteners shall not penetrate duct wall.
- D. Gasket: Comply with NFPA 96; grease-tight, high-temperature ceramic fiber, rated for minimum 2000 deg F (1093 deg C).
- E. Minimum Pressure Rating: 10-inch wg (2500 Pa), positive or negative.

2.09 FLEXIBLE CONNECTORS

- A. Materials: Flame-retardant or noncombustible fabrics.
- B. Coatings and Adhesives: Comply with UL 181, Class 1.
- C. Metal-Edged Connectors: Factory fabricated with a fabric strip 5-3/4 inches (146 mm) wide attached to two strips of 2-3/4-inch- (70-mm-) wide, 0.028-inch- (0.7-mm-) thick, galvanized sheet steel or 0.032-inch- (0.8-mm-) thick aluminum sheets. Provide metal compatible with connected ducts.
- D. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
 - 1. Minimum Weight: 26 oz./sq. yd. (880 g/sq. m).
 - 2. Tensile Strength: 480 lbf/inch (84 N/mm) in the warp and 360 lbf/inch (63 N/mm) in the filling.
 - 3. Service Temperature: Minus 40 to plus 200 deg F (Minus 40 to plus 93 deg C).
- E. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.
 - 1. Minimum Weight: 24 oz./sq. yd. (810 g/sq. m).
 - 2. Tensile Strength: 530 lbf/inch (93 N/mm) in the warp and 440 lbf/inch (77 N/mm) in the filling.
 - 3. Service Temperature: Minus 50 to plus 250 deg F (Minus 45 to plus 121 deg C).

2.10 FLEXIBLE DUCTS

- A. Noninsulated, Flexible Duct: UL 181, Class 1, 2-ply vinyl film supported by helically wound, spring-steel wire.
 - 1. Pressure Rating: 10-inch wg (2500 Pa) positive and 1.0-inch wg (250 Pa) negative.
 - 2. Maximum Air Velocity: 4000 fpm (20 m/s).
 - 3. Temperature Range: Minus 10 to plus 160 deg F (Minus 23 to plus 71 deg C).

- B. Insulated, Flexible Duct: UL 181, Class 1, aluminum laminate and polyester film with latex adhesive supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene vapor-barrier film.
1. Pressure Rating: 10-inch wg (2500 Pa) positive and 1.0-inch wg (250 Pa) negative.
 2. Maximum Air Velocity: 4000 fpm (20 m/s).
 3. Temperature Range: Minus 20 to plus 210 deg F (Minus 29 to plus 99 deg C).
 4. Insulation R-value: Comply with ASHRAE/IESNA 90.1.
- C. Flexible Duct Connectors:
1. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action in sizes 3 through 18 inches (75 through 460 mm), to suit duct size.
 2. Non-Clamp Connectors: Liquid adhesive plus tape or Adhesive plus sheet metal screws.

2.11 DUCT ACCESSORY HARDWARE

- A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.
- B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.
- B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and stainless-steel accessories in stainless-steel ducts.
- C. Install dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.
- D. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts.
1. Install steel volume dampers in steel ducts.
- E. Set dampers to fully open position before testing, adjusting, and balancing.
- F. Install test holes at fan inlets and outlets and elsewhere as indicated.

- G. Install fire dampers according to UL listing.
- H. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
 - 1. At outdoor-air intakes and mixed-air plenums.
 - 2. At drain pans and seals.
 - 3. Adjacent to and close enough to fire dampers, to reset or reinstall fusible links. Access doors for access to fire dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
 - 4. Control devices requiring inspection.
 - 5. Elsewhere as indicated.
- I. Install access doors with swing against duct static pressure.
- J. Access Door Sizes:
 - 1. One-Hand or Inspection Access: 8 by 5 inches (200 by 125 mm).
 - 2. Two-Hand Access: 12 by 6 inches (300 by 150 mm).
 - 3. Head and Hand Access: 18 by 10 inches (460 by 250 mm).
- K. Label access doors according to Section 23 05 53 "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.
- L. Install flexible connectors to connect ducts to equipment.
- M. Connect terminal units to supply ducts directly or with maximum 12-inch (300-mm) lengths of flexible duct. Do not use flexible ducts to change directions.
- N. Connect diffusers or light troffer boots to ducts with maximum 60-inch (1500-mm) lengths of flexible duct clamped or strapped in place.
- O. Install duct test holes where required for testing and balancing purposes.

3.02 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 - 1. Operate dampers to verify full range of movement.
 - 2. Inspect locations of access doors and verify that purpose of access door can be performed.
 - 3. Operate fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
 - 4. Inspect turning vanes for proper and secure installation.

END OF SECTION 23 33 00

SECTION 23 34 23
HVAC POWER VENTILATORS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
1. Centrifugal roof ventilators.
 2. In-line centrifugal fans.

1.02 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 2. Wiring Diagrams: For power, signal, and control wiring.
- C. Operation and maintenance data.

1.03 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. AMCA Compliance: Fans shall have AMCA-Certified performance ratings and shall bear the AMCA-Certified Ratings Seal.

PART 2 - PRODUCTS

2.01 CENTRIFUGAL ROOF VENTILATORS

- A. Housing: Removable, spun-aluminum, dome top and outlet baffle extruded-aluminum; square, one-piece, aluminum base with venturi inlet cone.
- B. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.
- C. Belt Drives:

1. Resiliently mounted to housing.
2. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
3. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
4. Pulleys: Cast-iron, adjustable-pitch motor pulley.
5. Fan and motor isolated from exhaust airstream.

D. Accessories:

1. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.
2. Bird Screens: Removable, **1/2-inch** mesh, aluminum or brass wire.
3. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.
4. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.

E. Roof Curbs: Galvanized steel; mitered and welded corners; **1-1/2-inch-thick**, rigid, fiberglass insulation adhered to inside walls; and **1-1/2-inch** wood nailer. Size as required to suit roof opening and fan base.

1. Configuration: Built-in raised cant and mounting flange.
2. Overall Height: **12 inches**.
3. Sound Curb: Curb with sound-absorbing insulation.
4. Pitch Mounting: Manufacture curb for roof slope.
5. Metal Liner: Galvanized steel.
6. Burglar Bars: 1/2 inch thick steel bars welded in place to form **6-inch** squares.
7. Mounting Pedestal: Galvanized steel with removable access panel.
8. Vented Curb: Unlined with louvered vents in vertical sides.

F. Capacities and Characteristics: as scheduled on drawings

2.02 IN-LINE CENTRIFUGAL FANS

- A. Housing: Split, spun aluminum with aluminum straightening vanes, inlet and outlet flanges, and support bracket adaptable to floor, side wall, or ceiling mounting.
- B. Direct-Drive Units: Motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing; with wheel, inlet cone, and motor on swing-out service door.
- C. Belt-Driven Units: Motor mounted on adjustable base, with adjustable sheaves, enclosure around belts within fan housing, and lubricating tubes from fan bearings extended to outside of fan housing.
- D. Fan Wheels: Aluminum, airfoil blades welded to aluminum hub.
- E. Accessories:
1. Volume-Control Damper: Manually operated with quadrant lock, located in fan outlet.
 2. Companion Flanges: For inlet and outlet duct connections.

3. Fan Guards: 1/2- by 1-inch mesh of galvanized steel in removable frame. Provide guard for inlet or outlet for units not connected to ductwork.
4. Motor and Drive Cover (Belt Guard): Epoxy-coated steel.

F. Capacities and Characteristics: as scheduled on drawings

2.03 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 23 05 13 "Common Motor Requirements for HVAC Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

B. Enclosure Type: Totally enclosed, fan cooled.

2.04 SOURCE QUALITY CONTROL

A. Certify fan performance ratings, including flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating." Label fans with the AMCA-Certified Ratings Seal.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Secure roof-mounted fans to roof curbs with cadmium-plated hardware. See Section 07 72 00 "Roof Accessories" for installation of roof curbs.
- B. Ceiling Units: Suspend units from structure; use steel wire or metal straps.
- C. Support suspended units from structure using threaded steel rods and elastomeric hangers or spring hangers having a static deflection of 1 inch. Install units with clearances for service and maintenance.

3.02 CONNECTIONS

- A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Section 23 33 00 "Air Duct Accessories."
- B. Install ducts adjacent to power ventilators to allow service and maintenance.
- C. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."

- D. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

3.03 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Verify that shipping, blocking, and bracing are removed.
2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
3. Verify that cleaning and adjusting are complete.
4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
5. Adjust belt tension.
6. Adjust damper linkages for proper damper operation.
7. Verify lubrication for bearings and other moving parts.
8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
9. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
10. Shut unit down and reconnect automatic temperature-control operators.
11. Remove and replace malfunctioning units and retest as specified above.

- B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

- C. Prepare test and inspection reports.

3.04 ADJUSTING

- A. Adjust damper linkages for proper damper operation.
- B. Adjust belt tension.
- C. Comply with requirements in Section 23 05 93 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.
- D. Replace fan and motor pulleys as required to achieve design airflow.
- E. Lubricate bearings.

END OF SECTION 23 34 23

SECTION 23 37 13**DIFFUSERS, REGISTERS, AND GRILLES**

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
1. Rectangular and square ceiling diffusers.
 2. Perforated diffusers.
 3. Adjustable bar registers and grilles.
 4. Fixed face registers and grilles.

1.02 SUBMITTALS

- A. Product Data: For each type of product indicated, include the following:
1. Data Sheet: For each type of diffuser, register or grill, indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.

PART 2 - PRODUCTS

2.01 CEILING DIFFUSERS

- A. Rectangular and Square Ceiling Diffusers:
1. Material: Steel.
 2. Finish: Baked enamel, white.
 3. Face Size: 24 by 24 inches (600 by 600 mm) nominal.
 4. Face Style: Three cone.
 5. Mounting: suitable for lay in ceiling.
 6. Pattern: Fixed.
 7. Dampers: Radial opposed blade or Butterfly.
 8. Accessories:
 - a. Equalizing grid.
 - b. Plaster ring.
 - c. Safety chain.
 - d. Wire guard.
 - e. Sectorizing baffles.
 - f. Operating rod extension.
- B. Perforated Diffuser:
1. Devices shall be specifically designed for variable-air-volume flows.

2. Material: Steel backpan and pattern controllers, with steel face.
3. Finish: Baked enamel, white.
4. Face Size: 24 by 24 inches (600 by 600 mm) nominal.
5. Duct Inlet: Round.
6. Face Style: Flush.
7. Mounting: suitable for lay in ceiling.
8. Pattern Controller: Four louvered deflector patches
9. Dampers: Opposed blade, Radial opposed blade or Butterfly.
10. Accessories:
 - a. Equalizing grid.
 - b. Plaster ring.
 - c. Safety chain.
 - d. Wire guard.
 - e. Sectorizing baffles.
 - f. Operating rod extension.

2.02 REGISTERS AND GRILLES

A. Adjustable Bar Register:

1. Material: Steel.
2. Finish: Baked enamel, white.
3. Face Blade Arrangement: Vertical spaced 3/4 inch (19 mm) apart.
4. Core Construction: Removable.
5. Rear-Blade Arrangement: Horizontal spaced 3/4 inch (19 mm) apart.
6. Frame: 1 inch (25 mm) wide.
7. Mounting: Countersunk screw.
8. Damper Type: Adjustable opposed blade.
9. Accessories:
 - a. Front-blade gang operator.

B. Fixed Bar Register (ER-1):

1. Material: Steel.
2. Finish: Baked enamel, white.
3. Face Blade Arrangement: Horizontal spaced 3/4 inch (19 mm) apart.
4. Core Construction: Removable.
5. Rear-Blade Arrangement: none
6. Frame: 1 inch (25 mm) wide.
7. Mounting: Countersunk screw or Concealed.
8. Damper Type: Adjustable opposed blade.

C. Fixed Face Grille (RG-1):

1. Material: Steel.
2. Finish: Baked enamel, white.
3. Face Arrangement: Perforated core.
4. Core Construction: Integral.
5. Frame: 1 inch (25 mm) wide.
6. Mounting: Lay in.

- D. Fixed Face Grille (RG-2):
1. Material: Steel.
 2. Finish: Baked enamel, white.
 3. Face Arrangement: 1/2-by-1/2-by-1/2-inch (13-by-13-by-13-mm) grid core.
 4. Core Construction: Integral.
 5. Frame: 1 inch (25 mm) wide.
 6. Mounting: Lay in.

2.03 SOURCE QUALITY CONTROL

- A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install diffusers, registers, and grilles level and plumb.
- B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.
- C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.02 ADJUSTING

- A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 23 37 13

SECTION 23 51 00**BREECHINGS, CHIMNEYS, AND STACKS****PART 1 - GENERAL****1.01 SUMMARY**

A. This Section includes the following:

1. Listed double-wall vents.

1.02 ACTION SUBMITTALS

A. Product Data: For the following:

1. Gas vents.
2. Flue Stacks

B. Shop Drawings: For vents and stacks. Include plans, elevations, sections, details, and attachments to other work.

PART 2 - PRODUCTS**2.01 LISTED TYPE B AND BW VENTS**

A. Description: Double-wall metal vents tested according to UL 441 and rated for **480 deg F (248 deg C)** continuously for Type B, or **550 deg F (288 deg C)** continuously for Type BW; with neutral or negative flue pressure complying with NFPA 211.

B. Construction: Inner shell and outer jacket separated by at least a **1/4-inch (6-mm)** airspace.

C. Inner Shell: **ASTM B 209 (ASTM B 209M)**, Type 1100 aluminum

D. Outer Jacket: Galvanized or Aluminized steel.

E. Accessories: Tees, elbows, increasers, draft-hood connectors, terminations, adjustable roof flashings, storm collars, support assemblies, thimbles, firestop spacers, and fasteners; fabricated from similar materials and designs as vent-pipe straight sections; all listed for same assembly.

1. Termination: Round chimney top designed to exclude minimum 98 percent of rainfall.

PART 3 - EXECUTION**3.01 APPLICATION**

- A. Listed Type B and BW Vents: Vents for certified gas appliances.

3.02 INSTALLATION OF LISTED VENTS

- A. Locate to comply with minimum clearances from combustibles and minimum termination heights according to product listing or NFPA 211, whichever is most stringent.
- B. Seal between sections of positive-pressure vents and grease exhaust ducts according to manufacturer's written installation instructions, using sealants recommended by manufacturer.
- C. Support vents at intervals recommended by manufacturer to support weight of vents and all accessories, without exceeding appliance loading.
- D. Slope breechings down in direction of appliance, with condensate drain connection at lowest point piped to nearest drain.
- E. Lap joints in direction of flow.
- F. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finishes.
- G. Clean breechings internally, during and after installation, to remove dust and debris. Clean external surfaces to remove welding slag and mill film. Grind welds smooth and apply touchup finish to match factory or shop finish.
- H. Provide temporary closures at ends of breechings, chimneys, and stacks that are not completed or connected to equipment.

END OF SECTION 23 51 00

SECTION 23 55 23.13**LOW-INTENSITY, GAS-FIRED, RADIANT HEATERS**

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes low-intensity, gas-fired, forced-draft radiant heaters.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings:
 - 1. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Include diagrams for power, signal, and control wiring.

1.03 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.04 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.05 WARRANTY

- A. Manufacturer's Special Warranty: Manufacturer agrees to repair or replace components of radiant heaters that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: All warranty periods listed below are from date of Substantial Completion.
 - a. Burner Assembly: Three years.
 - b. Combustion and Emitter Tubes: Three years.
 - c. Heater Controls: One year.

PART 2 - PRODUCTS**2.01 PERFORMANCE REQUIREMENTS**

- A. CSA certified, with CSA Seal and certification number clearly visible on units indicating compliance with ANSI Z83.20/CSA 2.34.
- B. UL listed and labeled, with UL label clearly visible on units indicating compliance with ANSI Z83.20/CSA 2.34.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.02 FORCED-DRAFT HEATERS

- A. Description: Factory-assembled, indoor, overhead-mounted, electrically controlled, low-intensity, infrared radiant heating units using gas combustion. Heater to have all necessary factory-installed wiring and piping required prior to field installation and startup.
- B. Fuel Type: Design burner for natural gas having characteristics same as those of gas available at Project site.
- C. Burner Assembly:
 - 1. Combustion-Air Inlet: Ducted horizontal to outdoors through sidewall with vent caps.
 - 2. Ignition System: 115/120-V ac with flame rod sensing capabilities and self-diagnostic control module.
- D. Combustion Chamber: 4-inch- (100-mm-) diameter, 16-gage, aluminized -steel tubing with high-emissivity, high-temperature, corrosion-resistant external finish.
- E. Emitter Tube: 4-inch- (100-mm-) diameter, 16-gage, aluminized-steel tubing with high-emissivity, high-temperature, corrosion-resistant external finish. Emitter tubing shall be equipped with baffles to maximize heating efficiency.
 - 1. Tubing Connections: Compression couplings made from aluminized or stainless steel.
 - 2. 90-degree-bend emitter steel tubing with high-emissivity, high-temperature, corrosion-resistant external finish.
- F. Reflector: Polished aluminum, with end caps. Shape to control radiation from tubing for uniform intensity at floor level with 100 percent cutoff above centerline of tubing. Reflectors or entire heater shall accommodate rotational adjustment from horizontal to a minimum 30-degree tilt from vertical.
- G. Capacities and Characteristics: As Scheduled on the Drawings

2.03 CONTROLS AND SAFETIES

- A. Gas Control Valve: Single-stage, regulated redundant 24-V ac gas valve that contains pilot solenoid valve, electric gas valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff all in one body.
- B. Failure Safeguards: 100 percent shutoff of gas flow in the event of flame or power failure.
- C. Prepurge of 30 seconds of air control system prior to burner ignition.
- D. Safety lockout of burner after three consecutive ignition failures.
- E. Blocked Vent Safety: Differential pressure switch in burner safety circuit to stop burner operation with high discharge or suction pressure.
- F. Control Panel Interlock: Stops burner if panel is open.
- G. Indicator Lights: "Airflow-on" and "burner-on" indicator lights.
- H. Thermostat: Single-stage, wall-mounted type with 50 to 90 deg F (10 to 32 deg C) operating range and fan on switch.
 - 1. Control Transformer: Integrally mounted.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Equipment Installation: Install gas-fired, radiant heaters and associated gas features and systems according to NFPA 54.
- B. Suspended Units: Suspend from substrate using chain hanger kits and building attachments or Mount to substrate using manufacturer's rigid mounting kits or custom fabricated brackets.
 - 1. Comply with requirements for hangers and supports specified in Section 23 05 29 "Hangers and Supports for HVAC Piping and Equipment."
- C. Maintain manufacturers' recommended clearances for combustibles.
- D. Gas Piping: Comply with Section 23 11 23 "Facility Natural-Gas Piping." Connect gas piping to gas train inlet; provide union with enough clearance for burner removal and service.
 - 1. Gas Connections: Connect gas piping to radiant heaters according to NFPA 54.
- E. Where installing piping adjacent to gas-fired, radiant heaters, allow space for service and maintenance.

- F. Vent Connections: Comply with Section 23 31 13 "Metal Ducts" and with Section 23 51 00 "Vents and Flues"
- G. Electrical Connections: Comply with applicable requirements in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."
 - 1. Install electrical devices furnished with heaters but not specified to be factory mounted.

3.02 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - 2. Verify bearing lubrication.
 - 3. Verify proper motor rotation.
 - 4. Test Reports: Prepare a written report to record the following:
 - a. Test procedures used.
 - b. Test results that comply with requirements.
 - c. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.
- B. Gas-fired, radiant heaters will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

3.03 ADJUSTING

- A. Adjust initial-temperature set points.
- B. Adjust burner and other unit components for optimum heating performance and efficiency.

END OF SECTION 23 55 23.13

SECTION 23 62 00**PACKAGED COMPRESSOR AND CONDENSER UNITS**

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes packaged, air-cooled, refrigerant compressor and condenser units for both the DOAS system and the VRF system.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. LEED Submittals:
 - 1. Product Data for Prerequisite EA 2: Documentation indicating that units comply with applicable requirements in ASHRAE/IESNA 90.1.
 - 2. Product Data for Credit EA 4: Documentation indicating that compressor and condenser units and refrigerants comply.
- C. Shop Drawings: For compressor and condenser units. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Wiring Diagrams: For power, signal, and control wiring.

1.03 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Fabricate and label refrigeration system according to ASHRAE 15, "Safety Standard for Refrigeration Systems."
- C. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6, "Heating, Ventilating, and Air-Conditioning."

1.04 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of compressor and condenser units that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Compressor failure.

- b. Condenser coil leak.
2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 VRF OUTDOOR UNITS (CU-1, CU-2)

- A. General: Condensing units for the VRF system shall be same manufacture as the VRF fan coil units specified in Section 23 82 19. The PURY outdoor units shall be equipped with multiple circuit boards that interface to the M-NET controls system and shall perform all functions necessary for operation. Each outdoor unit module shall be completely factory assembled, piped and wired and run tested at the factory.
 1. The model nomenclature and unit requirements are shown on the drawings. Outdoor unit shall have a sound rating no higher than 60 dB(A) individually or 64 dB(A) twinned. Units shall have a sound rating no higher than 50 dB(A) individually or 53 dB(A) twinned while in night mode operation. If an alternate manufacturer is selected, any additional material, cost, and labor to meet published sound levels shall be incurred by the contractor.
 2. Both refrigerant lines from the outdoor unit to the BC (Branch Circuit) Controller (Single or Main) shall be insulated.
 3. There shall be no more than 3 branch circuit controllers connected to any one outdoor unit.
 4. The outdoor unit shall have an accumulator with refrigerant level sensors and controls.
 5. The outdoor unit shall have a high pressure safety switch, over-current protection, crankcase heater and DC bus protection.
 6. The outdoor unit shall be capable of operating in heating mode down to -4°F ambient temperatures or cooling mode down to 23°F ambient temperatures, without additional low ambient controls. If an alternate manufacturer is selected, any additional material, cost, and labor to meet low ambient operating condition and performance shall be incurred by the contractor.
 7. The outdoor unit shall have a high efficiency oil separator plus additional logic controls to ensure adequate oil volume in the compressor is maintained.
 8. The outdoor unit shall be provided with a manufacturer supplied 20 gauge hot dipped galvanized snow/hail guard.
 9. Unit must defrost all circuits simultaneously in order to resume full heating more quickly. Partial defrost which may extend "no or reduced heating" periods shall not be allowed.
- B. Unit Cabinet:
 1. The casing(s) shall be fabricated of galvanized steel, bonderized and finished.
- C. Fan:
 1. Each outdoor unit module shall be furnished with one direct drive, variable speed propeller type fan. The fan shall be factory set for operation under 0 in. WG external static pressure, but capable of normal operation under a maximum of 0.24 in. WG external static pressure via dipswitch.

2. All fan motors shall have inherent protection, have permanently lubricated bearings, and be completely variable speed.
3. All fan motors shall be mounted for quiet operation.
4. All fans shall be provided with a raised guard to prevent contact with moving parts.
5. The outdoor unit shall have vertical discharge airflow.

D. Refrigerant

1. R410A refrigerant shall be required

E. Polyolester (POE) oil shall be required.

F. Coil:

1. The outdoor coil shall be of nonferrous construction with lanced or corrugated plate fins on copper tubing.
2. The coil fins shall have a factory applied corrosion resistant blue-fin finish.
3. The coil shall be protected with an integral metal guard.
4. Refrigerant flow from the outdoor unit shall be controlled by means of an inverter driven compressor.
5. The outdoor coil shall include 4 circuits with two position valves for each circuit, except for the last stage.

G. Compressor:

1. Each outdoor unit module shall be equipped with one inverter driven scroll hermetic compressor. Non inverter-driven compressors, which cause inrush current (demand charges) and require larger wire sizing, shall not be allowed.
2. A crankcase heater(s) shall be factory mounted on the compressor(s).
3. The outdoor unit compressor shall have an inverter to modulate capacity. The capacity shall be completely variable with a turndown of 19%-5% of rated capacity, depending upon unit size.
4. The compressor will be equipped with an internal thermal overload.
5. The compressor shall be mounted to avoid the transmission of vibration.

H. Controls:

1. The outdoor unit shall have the capability of up to 8 levels of demand control for each refrigerant system

I. Electrical:

1. The outdoor unit electrical power shall be 480volts, 3-phase, 60 hertz.
2. The outdoor unit shall be controlled by integral microprocessors.
3. The control circuit between the indoor units, BC Controller and the outdoor unit shall be 24VDC completed using a 2-conductor, twisted pair shielded cable to provide total integration of the system.

2.02 Branch CIRCUIT (BC) controllers FOR R2-SERIES SYSTEMS

- A. General: The BC (Branch Circuit) Controllers shall include multiple branches to allow simultaneous heating and cooling by allowing either hot gas refrigerant to flow to indoor

unit(s) for heating or subcooled liquid refrigerant to flow to indoor unit(s) for cooling. Refrigerant used for cooling must always be subcooled for optimal indoor unit LEV performance; alternate branch devices with no subcooling risk bubbles in liquid supplied to LEV and are not allowed.

The BC (Branch Circuit) Controllers shall be specifically used with R410A R2-Series systems. These units shall be equipped with a circuit board that interfaces to the M-NET controls system and shall perform all functions necessary for operation. The unit shall have a galvanized steel finish. The BC Controller shall be completely factory assembled, piped and wired. Each unit shall be run tested at the factory. This unit shall be mounted indoors, with access and service clearance provided for each controller. The sum of connected capacity of all indoor air handlers shall range from 50% to 150% of rated capacity.

B. BC Unit Cabinet:

1. The casing shall be fabricated of galvanized steel or factory standard baked enamel finish
2. Each cabinet shall house a liquid-gas separator and multiple refrigeration control valves.
3. The unit shall house tube-in-tube heat exchangers.

C. Refrigerant

1. R410A refrigerant shall be required.

D. Refrigerant valves:

1. The unit shall be furnished with multiple branch circuits which can individually accommodate up to 54,000 BTUH and up to three indoor units. Branches may be twinned to allow more than 54,000 BTUH.
2. Each branch shall have multiple two-position valves to control refrigerant flow.
3. Service shut-off valves shall be field-provided/installed for each branch to allow service to any indoor unit without field interruption to overall system operation.
4. Linear electronic expansion valves shall be used to control the variable refrigerant flow.

E. Future Use

1. Each VRF system shall include at least one (1) unused branches or branch devices for future use. Branches shall be fully installed & wired in central location with capped service shutoff valve & service port.

F. Integral Drain Pan:

1. 1. An Integral drain pan and drain shall be provided

G. Electrical:

1. The unit electrical power shall be 480 volts, 1 phase, 60 Hertz.
2. The BC Controller shall be controlled by integral microprocessors
3. The control circuit between the indoor units and outdoor units shall be 24VDC completed using a 2-conductor, twisted pair shielded cable to provide total integration of the system.

2.03 COMPRESSOR AND CONDENSER UNITS, AIR COOLED (CU-3)

- A. Refrigerant: R-410A.
- B. Condenser Coil: Seamless copper-tube, aluminum-fin coil, including subcooling circuit and backseating liquid-line service access valve. Factory pressure test coils, then dehydrate by drawing a vacuum and fill with a holding charge of nitrogen or refrigerant.
- C. Condenser Fan: Propeller-type vertical discharge; either directly or belt driven. Include the following:
 - 1. Permanently lubricated, ball-bearing totally enclosed motors.
 - 2. Separate motor for each fan.
 - 3. Dynamically and statically balanced fan assemblies.
- D. Operating and safety controls include the following:
 - 1. Manual-reset, high-pressure cutout switches.
 - 2. Automatic-reset, low-pressure cutout switches.
 - 3. Low-oil-pressure cutout switch.
 - 4. Compressor-winding thermostat cutout switch.
 - 5. Three-leg, compressor-overload protection.
 - 6. Control transformer.
 - 7. Magnetic contactors for compressor and condenser fan motors.
 - 8. Timer to prevent excessive compressor cycling.
- E. Accessories:
 - 1. Low-Ambient Controller: Controls condenser fan speed to permit operation down to **minus 20 deg F (minus 29 deg C)** with time-delay relay to bypass low-pressure switch.
 - 2. Gage Panel: Package with refrigerant circuit suction and discharge gages.
 - 3. Part-winding-start timing relay, circuit breakers, and contactors.
- F. Unit Casings: Designed for outdoor installation with weather protection for components and controls and with removable panels for required access to compressors, controls, condenser fans, motors, and drives. Additional features include the following:
 - 1. Steel, galvanized or zinc coated, for exposed casing surfaces; treated and finished with manufacturer's standard paint coating.
 - 2. Perimeter base rail with forklift slots and lifting holes to facilitate rigging.
 - 3. Gasketed control panel door.
 - 4. Nonfused disconnect switch, factory mounted and wired, for single external electrical power connection. If factory mounted is not available, provide disconnect for mounting in the field by Division 23 contractor.
 - 5. Condenser coil grille.
- G. Capacities and Characteristics: As Scheduled on the Drawings

2.04 SOURCE QUALITY CONTROL

- A. Energy Efficiency: Equal to or greater than prescribed by ASHRAE/IESNA 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings," Section 6, "Heating, Ventilating, and Air-Conditioning."
- B. Testing Requirements: Factory test sound-power-level ratings according to ARI 270.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install units level and plumb, firmly anchored in locations indicated.
- B. Install roof-mounting units on equipment supports specified in Section 07 72 00 "Roof Accessories."
- C. Maintain manufacturer's recommended clearances for service and maintenance.
- D. Loose Components: Install electrical components, devices, and accessories that are not factory mounted.

3.02 CONNECTIONS

- A. Comply with requirements for piping in Section 23 21 13 "Hydronic Piping" and Section 23 21 16 "Hydronic Piping Specialties." Section 15179 "Hydronic Piping Specialties." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.
- C. Connect precharged refrigerant tubing to unit's quick-connect fittings. Install tubing so it does not interfere with access to unit. Install furnished accessories.
- D. Connect refrigerant piping to condenser units; maintain required access to unit. Install furnished field-mounted accessories. Refrigerant piping and specialties are specified in Section 23 23 00 "Refrigerant Piping."

3.03 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections: Provide factory representative startup and first year warranty site visits
 - 1. Perform each visual and mechanical inspection and electrical test. Certify compliance with test parameters.

2. Leak Test: After installation, charge system with refrigerant and oil and test for leaks. Repair leaks, replace lost refrigerant and oil, and retest until no leaks exist.
 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor operation and unit operation, product capability, and compliance with requirements.
 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 5. Verify proper airflow over coils.
- C. Verify that vibration isolation and flexible connections properly dampen vibration transmission to structure.

END OF SECTION 23 62 00

SECTION 23 74 33**DEDICATED OUTDOOR-AIR UNITS**

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section includes factory-packaged units capable of supplying up to 100 percent outdoor air and providing cooling and heating.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include rated capacities, operating characteristics, and furnished specialties and accessories.

- B. LEED Submittals:

1. Product Data for Prerequisite EA 2: Documentation indicating that units comply with applicable requirements in ASHRAE/IESNA 90.1.
2. Product Data for Prerequisite EA 3: Documentation indicating that refrigerants comply.
3. Product Data for Credit EA 4: Documentation indicating that equipment and refrigerants comply.
4. Product Data for Prerequisite IEQ 1: Documentation indicating that units comply with ASHRAE 62.1, Section 5 - "Systems and Equipment."
5. Product Data for Credit IEQ 1: Documentation indicating that units are equipped with a direct outdoor airflow-measuring device capable of measuring the minimum outdoor airflow with accuracy within 15 percent of the design minimum airflow rate, as defined by ASHRAE 62.1.
6. Product Data for Credit IEQ 4.1: For solvent cements and adhesive primers, documentation including printed statement of VOC content.
7. Laboratory Test Reports for Credit IEQ 4: For solvent cements and adhesive primers, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
8. Product Data for Credit IEQ 5: Documentation indicating that units include MERV 13 filters rated according to ASHRAE 52.2.

- C. Shop Drawings:

1. Include plans, elevations, sections, and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Prepare the following by or under the supervision of a qualified professional engineer:
 - a. Mounting Details: For securing and flashing roof curb to roof structure. Indicate coordinating requirements with roof membrane system.
 - b. Include diagrams for power, signal, and control wiring.
 - c. Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
 - d. Indicate compliance with "Performance Requirements" article.

1.04 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Roof-curb mounting details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 1. Size and location of unit-mounted rails and anchor points and methods for anchoring units to roof curb.
 2. Required roof penetrations for ducts, pipes, and electrical raceways, including size and location of each penetration.
- B. Seismic Qualification Certificates: For dedicated outdoor-air units, accessories, and components, from manufacturer.
 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Startup service reports.
- D. Sample Warranty: For special warranty.

1.05 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For units to include in emergency, operation, and maintenance manuals.

1.06 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fan Belts: One set for each belt-driven fan.
2. Filters: One set.

1.07 WARRANTY

- A. Special Warranty: Manufacturer agrees to replace components of units that fail in materials or workmanship within specified warranty period.
1. Warranty Period for Compressors: Five years from date of Substantial Completion.
 2. Warranty Period for Heat Exchangers: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:
1. AAON.
 2. Addison.
 3. Desert Aire.
 4. Engineered Air.
 5. Munters Corporation, Dehumidification Division; Des Champs Products.
 6. Thomas & Betts Corporation; Reznor HVAC Division.

2.02 PERFORMANCE REQUIREMENTS

- A. General Fabrication Requirements: Comply with requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment," and Section 7 - "Construction and System Start-up."
- B. Seismic Performance: Units shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
- C. Cabinet Thermal Performance:
1. Maximum Overall U-Value: Comply with requirements in ASHRAE/IESNA 90.1.
 2. Include effects of metal-to-metal contact and thermal bridges in the calculations.
- D. Cabinet Surface Condensation:

1. Cabinet shall have additional insulation and vapor seals if required to prevent condensation on the interior and exterior of the cabinet.
 2. Portions of cabinet located downstream from the cooling coil shall have a thermal break at each thermal bridge between the exterior and interior casing to prevent condensation from occurring on the interior and exterior surfaces. The thermal break shall not compromise the structural integrity of the cabinet.
- E. Maximum Cabinet Leakage: 0.5 percent of the total supply-air flow at a pressure rating equal to the fan shut-off pressure.
- F. Cabinet Deflection Performance:
1. Walls and roof deflection shall be within 1/200 of the span at the design working pressure equal to the fan shut-off pressure. Deflection limits shall be measured at any point on the surface.
 2. Floor deflections shall be within 1/300 of the span considering the worst-case condition caused by the following:
 - a. Service personnel.
 - b. Internal components.
 - c. Design working pressure defined for the walls and roof.
- G. Electrical components, devices, and accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- H. Capacities and Characteristics: As scheduled on the drawings

2.03 CABINET

- A. Construction: double wall.
- B. Exterior Casing Material: Galvanized steel with paint finish.
- C. Interior Casing Material: Galvanized steel.
- D. Lifting and Handling Provisions: Factory-installed shipping skids and lifting lugs.
- E. Base Rails: Galvanized-steel rails for mounting on roof curb or pad as indicated.
- F. Access for Inspection, Cleaning, and Maintenance: Comply with requirements in ASHRAE 62.1.
1. Service Doors: Hinged access doors with gaskets. Material and construction of doors shall match material and construction of cabinet in which doors are installed.
- G. Floor: Reinforced, metal surface; reinforced to limit deflection when walked on by service personnel. Insulation shall be below metal walking surface.
- H. Cabinet Insulation:

1. Type: Fibrous-glass duct lining complying with ASTM C 1071, Type II or flexible elastomeric insulation complying with ASTM C 534, Type II, sheet materials.
2. Thickness: 2 inches (50 mm).
3. Insulation Adhesive: Comply with ASTM C 916, Type I.
4. Mechanical Fasteners: Suitable for adhesive, mechanical, or welding attachment to casing without damaging liner and without causing air leakage when applied as recommended by manufacturer.

I. Condensate Drain Pans:

1. Shape: Rectangular, with 1 percent slope in at least two planes to direct water toward drain connection.
2. Size: Large enough to collect condensate from cooling coils including coil piping connections, coil headers, and return bends.
 - a. Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.
 - b. Depth: A minimum of 2 inches (50 mm) deep.
3. Configuration: Single wall.
4. Configuration: Double wall, with space between walls filled with foam insulation and moisture-tight seal.
5. Material: Galvanized-steel sheet with asphaltic waterproofing compound coating on pan top surface.
6. Material: Stainless-steel sheet.
7. Drain Connection:
 - a. Located on one end of pan, at lowest point of pan.
 - b. Terminated with threaded nipple.
 - c. Minimum Connection Size: NPS 1 (DN 25).
8. Units with stacked coils shall have an intermediate drain pan to collect condensate from top coil.

J. Surfaces in Contact with Airstream: Comply with requirements in ASHRAE 62.1 for resistance to mold and erosion.

2.04 SUPPLY FAN

A. Forward-Curved Fan Type: Centrifugal; statically and dynamically balanced.

1. Fan Wheel Material: Galvanized or Painted steel, mounted on solid-steel shaft.
2. Bearings: Self-aligning, permanently lubricated ball bearings or Pillow-block bearings rated L₅₀ for 200,000 hours and having external grease fittings.

B. Plenum Fan Type: Single width, non-overloading, with backward-inclined or airfoil blades.

1. Fan Wheel Material: Aluminum; attached directly to motor shaft.
2. Fan Wheel Drive and Arrangement: Direct drive, AMCA Arrangement 4.

3. Fan panel and frame Material: Powder-coated steel, stainless steel, or aluminum.
 4. Fan Enclosure: Easily removable enclosure around rotating parts.
 5. Fan Balance: Precision balance fan below 0.08 inch/s (2.0 mm/s) at design speed with filter in.
- C. Service Factor for Belt Drive Applications: Multiple V-belt drive with matching fan pulley and adjustable motor sheaves and belt assembly with minimum 1.5 service factor.
- D. Motor: Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for high efficient motors per Section 23 05 13 "COMMON MOTOR REQUIREMENTS FOR HVAC."
1. Enclosure Type: Totally enclosed, fan cooled.
 2. NEMA Premium (TM) efficient motors as defined in NEMA MG 1.
 3. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
 4. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
 5. Mount unit-mounted disconnect switches on exterior of unit.
- E. Mounting: Fan wheel, motor, and drives shall be mounted to fan casing with spring isolators.

2.05 COOLING COILS

- A. Capacity Ratings: Comply with ASHRAE 33 and ARI 410 and coil bearing the ARI label.
- B. Coil Casing Material: Manufacturer's standard material.
- C. Tube Material: Copper.
- D. Tube Header Material: Manufacturer's standard material.
- E. Fin Material: Aluminum or Copper.
- F. Fin and Tube Joints: Mechanical bond.
- G. Leak Test: Coils shall be leak tested with air underwater.
- H. Refrigerant Coil Capacity Reduction: Circuit coils for face, row or interleaved control.
- I. Refrigerant Coil Suction and Distributor Header Materials: Seamless copper tube with brazed joints.
- J. Coating: Phenolic epoxy corrosion-protection coating after assembly.

2.06 REFRIGERATION SYSTEM

- A. Comply with requirements in ASHRAE 15, "Safety Standard for Refrigeration Systems."

- B. Refrigerant Charge: Factory charged with refrigerant and filled with oil.
- C. Compressors: Scroll compressors with integral vibration isolators, internal overcurrent and overtemperature protection, internal pressure relief, and crankcase heater.
- D. Refrigerant: R-410A.
 - 1. Classified as Safety Group A1 according to ASHRAE 34.
 - 2. Provide unit with operating charge of refrigerant.
- E. Refrigeration System Specialties:
 - 1. Expansion valve with replaceable thermostatic element.
 - 2. Refrigerant dryer.
 - 3. High-pressure switch.
 - 4. Low-pressure switch.
 - 5. Thermostat for coil freeze-up protection during low ambient temperature operation or loss of air.
 - 6. Brass service valves installed in discharge and liquid lines.
- F. Capacity Control:
 - 1. Hot-gas bypass refrigerant control for capacity control with continuous dehumidification on a single compressor.
 - 2. Patented, Rawal APR control with zero to 100 percent modulating capacity control using hot-gas bypass. Evaporator coil shall be continuously active for dehumidification.
 - 3. Single compressor with evaporator and condenser coil within the refrigerant section to provide initial pre-cooling and to reheat for humidity control.
 - 4. Heat-pipe heat exchanger wrapped around the evaporator coil to pre-cool the air entering the evaporator coil and reheat the air leaving the evaporator coil to control humidity.
- G. Refrigerant reheat condenser coils:
 - 1. Capacity Ratings: Complying with ASHRAE 33 and ARI 410 and coil bearing the ARI label.
 - 2. Tube Material: Copper.
 - 3. Fin Material: Aluminum or Copper.
 - 4. Fin and Tube Joint: Mechanical bond.
 - 5. Leak Test: Coils shall be leak tested with air underwater.
 - 6. Coating: Phenolic epoxy corrosion-protection coating after assembly.
- H. Safety Controls:
 - 1. Compressor motor and condenser coil fan motor low ambient lockout.
 - 2. Overcurrent protection for compressor motor.

2.07 INDIRECT-FIRED GAS FURNACE HEATING

A. Furnace Assembly:

1. Factory assembled, piped, and wired.
2. Comply with requirements in NFPA 54, "National Fuel Gas Code," and ANSI Z21.47, "Gas-Fired Central Furnaces."
3. AGA Approval: Designed and certified by and bearing label of AGA.

B. Burners:

1. Heat-Exchanger Material: Aluminized steel with stainless-steel inserts with a minimum thermal efficiency of 90 percent.
2. Fuel: Natural gas.
3. Ignition: Electronically controlled electric spark with flame sensor.

C. Heat-Exchanger Drain Pan Material: Stainless steel.

D. Venting: Power vent with integral, motorized centrifugal fan interlocked with gas valve. Provide both PVC flue and combustion air for connection to combination flue/combustion air for high efficiency furnace.

E. Safety Controls:

1. Gas Control Valve: Two stage.
2. Gas Train: Single-body, regulated, redundant, 24-V ac gas valve assembly containing pilot solenoid valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff.

2.08 FILTERS

A. Disposable Panel Filters:

1. Comply with NFPA 90A.
2. Factory-fabricated, viscous-coated, flat-panel type.
3. Thickness: 2 inches (50 mm).
4. Minimum Efficiency: 35%.
5. Media: Interlaced glass fibers sprayed with nonflammable adhesive.

B. Extended-Surface, Disposable Panel Filters:

1. Comply with NFPA 90A.
2. Factory-fabricated, dry, extended-surface type.
3. Thickness: 12 inches (600 mm).
4. Minimum efficiency: 85%
5. Media: Fibrous material formed into deep-V-shaped pleats and held by self-supporting wire grid.

C. Mounting Frames:

1. Panel filters arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or from access plenum.
2. Extended surface filters arranged for flat orientation, removable from access plenum.
3. Galvanized or stainless steel with gaskets and fasteners, suitable for bolting together into built-up filter banks with space for prefilter.

2.09 ELECTRICAL POWER CONNECTIONS

- A. General Electrical Power Connection Requirements: Factory-installed and -wired switches, motor controllers, transformers, and other necessary electrical devices shall provide a single-point field power connection to unit.
- B. Enclosure: NEMA 250, Type 3R, mounted in unit with hinged access door in unit cabinet having a lock and key or padlock and key,
- C. Wiring: Numbered and color-coded to match wiring diagram.
- D. Wiring Location: Install factory wiring outside an enclosure in a raceway.
- E. Power Interface: Field power interface shall be to NEMA KS 1, heavy-duty, nonfused disconnect switch.
- F. Factory Wiring: Branch power circuit to each motor and to controls with one of the following disconnecting means:
 1. NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 60947-4-1.
 2. NEMA KS 1, heavy-duty, nonfusible switch.
 3. UL 489, motor-circuit protector (circuit breaker) with field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
- G. Factory-Mounted, Overcurrent-Protection Service: For each motor.
- H. Transformer: Factory mounted with primary and secondary fuses and sized with enough capacity to operate electrical load plus spare capacity.
- I. Controls: Factory wire unit-mounted controls where indicated.
- J. Lights: Factory wire unit-mounted lights.
- K. Receptacle: Factory wire unit-mounted, ground fault interrupt (GFI) duplex receptacle.
- L. Control Relays: Auxiliary and adjustable time-delay relays.

2.10 CONTROLS

- A. Control equipment and sequence of operation are specified in Section 23 09 00 "Instrumentation and Control for HVAC."

- B. Control Wiring: Factory wire connection for controls' power supply.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for piping, ducts, and electrical systems to verify actual locations of connections before equipment installation.
- C. Examine roof curbs and equipment supports for suitable conditions where units will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Comply with manufacturer's rigging and installation instructions for unloading units and moving to final locations.
- B. Equipment Mounting:
 - 1. Install air units on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 03 30 00 "Cast-in-Place Concrete."
 - 2. Comply with requirements for vibration isolation and seismic control devices specified in Section 23 05 48 "Vibration and Seismic Controls for HVAC."
- C. Install wall- and duct-mounted sensors furnished by manufacturer for field installation. Install control wiring and make final connections to control devices and unit control panel.
- D. Comply with requirements for gas-fired furnace installation in NFPA 54, "National Fuel Gas Code."
- E. Install separate devices furnished by manufacturer and not factory installed.
- F. Install new filters at completion of equipment installation and before testing, adjusting, and balancing.
- G. Install drain pipes from unit drain pans to sanitary drain.
 - 1. Drain Piping: Drawn-temper copper water tubing complying with **ASTM B 88, Type L (ASTM B 88M, Type B)**, with soldered joints.
 - 2. Drain Piping: Schedule 40 PVC pipe complying with ASTM D 1785, with solvent-welded fittings.

- a. PVC solvent cement shall have a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - b. Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - c. Solvent cement and adhesive primer shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
3. Pipe Size: Same size as condensate drain pan connection.

3.03 CONNECTIONS

- A. Where installing piping adjacent to units, allow space for service and maintenance.
- B. Refrigerant Piping Connections:
1. Comply with requirements in Section 23 23 00 "Refrigerant Piping."
- C. Gas Piping Connections:
1. Comply with requirements in Section 23 11 23 "Facility Natural-Gas Piping."
 2. Connect gas piping to furnace, full size of gas train inlet, and connect with union, and shutoff valve with sufficient clearance for burner removal and service.
 3. Install AGA-approved flexible connectors.
- D. Duct Connections:
1. Comply with requirements in Section 23 31 13 "Metal Ducts."
 2. Drawings indicate the general arrangement of ducts.
 3. Connect ducts to units with flexible duct connectors. Comply with requirements for flexible duct connectors in Section 23 33 00 "Air Duct Accessories."
- E. Electrical Connections: Comply with requirements for power wiring, switches, and motor controls in electrical Sections.
1. Install electrical devices furnished by unit manufacturer but not factory mounted.

3.04 STARTUP SERVICE

- A. Perform startup service.
1. Complete installation and startup checks according to manufacturer's written instructions.
 2. Inspect units for visible damage to furnace combustion chamber.
 3. Perform the following operations for both minimum and maximum firing and adjust burner for peak efficiency:
 - a. Measure gas pressure at manifold.

- b. Measure combustion-air temperature at inlet to combustion chamber.
 - c. Measure flue-gas temperature at furnace discharge.
 - d. Perform flue-gas analysis. Measure and record flue-gas carbon dioxide and oxygen concentration.
 - e. Measure supply-air temperature and volume when burner is at maximum firing rate and when burner is off. Calculate useful heat to supply air.
4. Verify operation of remote panel including pilot-light operation and failure modes. Inspect the following:
 - a. High-limit heat exchanger.
 - b. Alarms.
 5. Inspect units for visible damage to refrigerant compressor, condenser and evaporator coils, and fans.
 6. Start refrigeration system when outdoor-air temperature is within normal operating limits and measure and record the following:
 - a. Cooling coil leaving-air, dry- and wet-bulb temperatures.
 - b. Cooling coil entering-air, dry- and wet-bulb temperatures.
 7. Simulate maximum cooling demand and inspect the following:
 - a. Compressor refrigerant suction and hot-gas pressures.
 - b. Short-circuiting of air through outside coil or from outside coil to outdoor-air intake.
 8. Inspect casing insulation for integrity, moisture content, and adhesion.
 9. Verify that clearances have been provided for servicing.
 10. Verify that controls are connected and operable.
 11. Verify that filters are installed.
 12. Clean coils and inspect for construction debris.
 13. Clean furnace flue and inspect for construction debris.
 14. Inspect operation of power vents.
 15. Purge gas line.
 16. Inspect and adjust vibration isolators and seismic restraints.
 17. Verify bearing lubrication.
 18. Clean fans and inspect fan-wheel rotation for movement in correct direction without vibration and binding.
 19. Adjust fan belts to proper alignment and tension.
 20. Start unit.
 21. Inspect and record performance of interlocks and protective devices including response to smoke detectors by fan controls and fire alarm.
 22. Operate unit for run-in period.
 23. Calibrate controls.
 24. Adjust and inspect high-temperature limits.
 25. Inspect outdoor-air dampers for proper stroke.
 26. Verify operational sequence of controls.
 27. Measure and record the following airflows. Plot fan volumes on fan curve.
 - a. Supply-air volume.

- b. Return-air flow.
 - c. Outdoor-air flow.
- B. After startup, change filters, verify bearing lubrication, and adjust belt tension.
 - C. Remove and replace components that do not properly operate and repeat startup procedures as specified above.
 - D. Prepare written report of the results of startup services.

3.05 ADJUSTING

- A. Adjust initial temperature and humidity set points.
- B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
- C. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.06 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION 23 74 33

SECTION 23 82 19**FAN COIL UNITS****PART 1 - GENERAL****1.01 SUMMARY**

- A. Section includes fan coil units and accessories for Variable Refrigerant Flow (VRF) units.
- B. The variable capacity, heat pump heat recovery air conditioning system shall be equal to a Mitsubishi VRFZ (Variable Refrigerant Flow Zoning), which is the basis of design. Other manufacturers include Daikin, LG and Sanyo. If system configuration and other parameters are changed to meet equal manufacturer standards, changes to plans shall be the responsibility of the manufacturer and shall be submitted at the Action and Informational Submittal Phases for engineer and architect review.
- C. The system shall consist of a outdoor unit (CU-1 & CU-2 specified in Section 23 62 00), BC (Branch Circuit) Controller or controllers, multiple indoor units, and BACNET based (BTL Listed) DDC (Direct Digital Controls). Each indoor unit or group of indoor units shall be capable of operating in any mode independently of other indoor units or groups. System shall be capable of changing mode (cooling to heating, heating to cooling) with no interruption to system operation. To ensure owner comfort, each indoor unit or group of indoor units shall be independently controlled and capable of changing mode automatically when zone temperature strays 1.8 degrees F from set point for ten minutes. The sum of connected capacity of all indoor air handlers shall range from 50% to 150% of outdoor rated capacity.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. LEED Submittals:
 - 1. Product Data for Prerequisite IEQ 1: Documentation indicating that units comply with ASHRAE 62.1, Section 5 - "Systems and Equipment."
- C. Shop Drawings:
 - 1. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Include diagrams for power, signal, and control wiring.
- D. Samples: For units with factory-applied color finishes.

1.03 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: If system is of different manufacture than basis of design and layout or design is different than that shown on drawings, submit drawings showing unit layout, locations, branch controllers number and locations, refrigerant pipe routings and piping schematics, etc. This will include a revised drawing similar to Drawing M401.
- B. Seismic Qualification Certificates: For fan coil units, accessories, and components, from manufacturer.
- C. Field quality-control reports.
- D. Sample warranty.

1.04 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.05 QUALITY ASSURANCE

- A. Comply with NFPA 70.
- B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- C. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
- D. The units shall be listed by Electrical Testing Laboratories (ETL) and bear the ETL label.
- E. All wiring shall be in accordance with the National Electrical Code (N.E.C.).
- F. The units shall be manufactured in a facility registered to ISO 9001 and ISO14001 which is a set of standards applying to environmental protection set by the International Standard Organization (ISO).
- G. All units must meet or exceed the 2010 Federal minimum efficiency requirements and the proposed ASHRAE 90.1 efficiency requirements for VRF systems. Efficiency shall be published in accordance with the DOE alternative test procedure, which is based on the Air-Conditioning, Heating, and Refrigeration Institute (AHRI) Standards 340/360, 1230 and ISO Standard 13256-1.
- H. A full charge of R-410A for the condensing unit only shall be provided in the condensing unit.

PART 2 - PRODUCTS**2.01 SYSTEM DESCRIPTION**

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Factory-packaged and -tested units rated according to AHRI 440, ASHRAE 33, and UL 1995.

2.02 4-WAY CEILING-RECESSED CASSETTE WITH GRILLE

- A. This unit shall be a four-way cassette style indoor unit that recesses into the ceiling with a ceiling grille. The indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, electronic modulating linear expansion device, control circuit board and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, an auto restart function, an emergency operation function, a test run switch, and the ability to adjust airflow patterns for different ceiling heights. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory.
- B. Unit Cabinet:
 - 1. The cabinet shall be space-saving ceiling-recessed cassette.
 - 2. The cabinet panel shall have provisions for a field installed filtered outside air intake.
 - 3. Branch ducting shall be allowed from cabinet.
 - 4. Four-way grille shall be fixed to bottom of cabinet allowing two, three or four-way blow.
 - 5. The grille vane angles shall be individually adjustable from the wired remote controller to customize the airflow pattern for the conditioned space
- C. Fan:
 - 1. The indoor fan shall be an assembly with a turbo fan direct driven by a single motor.
 - 2. The indoor fan shall be statically and dynamically balanced to run on a motor with permanently lubricated bearings.
 - 3. The indoor fan shall consist of five (5) speed settings, Low, Mid1, Mid2, High and Auto.
 - 4. The fan shall have a selectable Auto fan setting that will adjust the fan speed based on the difference between controller set-point and space temperature.
 - 5. The indoor unit shall have an adjustable air outlet system offering 4-way airflow, 3-way airflow, or 2-way airflow.
 - 6. The indoor unit shall have switches that can be set to provide optimum airflow based on ceiling height and number of outlets used.
 - 7. The indoor unit vanes shall have 5 fixed positions and a swing feature that shall be capable of automatically swinging the vanes up and down for uniform air distribution.

- D. The vanes shall have an Auto-Wave selectable option in the heating mode that shall randomly cycle the vanes up and down to evenly heat the space. Filter:
 - 1. Return air shall be filtered by means of a long-life washable filter
- E. Coil:
 - 1. The indoor coil shall be of nonferrous construction with smooth plate fins on copper tubing.
 - 2. The tubing shall have inner grooves for high efficiency heat exchange.
 - 3. All tube joints shall be brazed with phos-copper or silver alloy.
 - 4. The coils shall be pressure tested at the factory.
 - 5. A condensate pan and drain shall be provided under the coil.
 - 6. The unit shall be provided with an integral condensate lift mechanism that will be able to raise drain water 33 inches above the condensate pan.
 - 7. Both refrigerant lines to the PLFY indoor units shall be insulated.

2.03 4-WAY CEILING-RECESSED CASSETTE WITH GRILLE INDOOR UNIT

- A. General: This shall be a four-way cassette style indoor unit that recesses into the ceiling with a ceiling grille. The indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, electronic modulating linear expansion device, control circuit board and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, an auto restart function, an emergency operation function and a test run switch. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory.
- B. Unit Cabinet:
 - 1. The cabinet shall be a compact 22-7/16" wide x 22-7/16" deep so it will fit within a standard 24" square suspended ceiling grid.
 - 2. The cabinet panel shall have provisions for a field installed filtered outside air intake.
 - 3. Four-way grille shall be fixed to bottom of cabinet allowing two, three or four-way blow.
- C. Fan:
 - 1. The indoor fan shall be an assembly with a turbo fan direct driven by a single motor.
 - 2. The indoor fan shall be statically and dynamically balanced to run on a motor with permanently lubricated bearings.
 - 3. The indoor fan shall consist of three (3) speeds, Low, Mid, and High.
 - 4. The indoor unit shall have an adjustable air outlet system offering 4-way airflow, 3-way airflow, or 2-way airflow.
 - 5. The auto air swing vanes shall be capable of automatically swinging up and down for uniform air distribution.
- D. Filter:
 - 1. Return air shall be filtered by means of a long-life washable filter.
- E. Coil:

1. The indoor coil shall be of nonferrous construction with smooth plate fins on copper tubing.
2. The tubing shall have inner grooves for high efficiency heat exchange.
3. All tube joints shall be brazed with phos-copper or silver alloy.
4. The coils shall be pressure tested at the factory.
5. A condensate pan and drain shall be provided under the coil.
6. The unit shall be provided with an integral condensate lift mechanism that will be able to raise drain water 19-3/4" inches above the condensate pan.
7. Both refrigerant lines to the PLFY indoor units shall be insulated.

2.04 1-WAY CEILING-RECESSED CASSETTE WITH GRILLE INDOOR UNIT

- A. General: This shall be a one-way cassette indoor unit that recesses into the ceiling with a ceiling grille and shall have a modulating linear expansion device. The indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, electronic modulating linear expansion device, control circuit board and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, an auto restart function, an emergency operation function and a test run switch. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory.
- B. Unit Cabinet:
1. The cabinet shall be space-saving ceiling recessed.
 2. The cabinet panel shall have provisions for a field installed filtered outside air intake.
 3. Branch ducting shall be allowed from cabinet.
 4. The one-way grille shall be fixed to bottom of cabinet allowing for one-way airflow.
- C. Fan:
1. The indoor fan shall be an assembly with one line-flow fan direct driven by a single motor.
 2. The indoor fan shall be statically and dynamically balanced to run on a motor with permanently lubricated bearings.
 3. The indoor fan shall consist of four (4) speeds, Low, Mid1, Mid2, and High.
- D. Filter:
1. Return air shall be filtered by means of a long-life washable permanent filter.
- E. Coil:
1. The indoor coil shall be of nonferrous construction with smooth plate fins on copper tubing.
 2. The tubing shall have inner grooves for high efficiency heat exchange.
 3. All tube joints shall be brazed with phos-copper or silver alloy.
 4. The coils shall be pressure tested at the factory.
 5. A condensate pan and drain shall be provided under the coil.
 6. The unit shall be provided with an integral condensate lift mechanism able to raise drain water 23 inches above the condensate pan.

7. Both refrigerant lines to the PMFY indoor units shall be insulated.

2.05 CEILING-CONCEALED DUCTED INDOOR UNIT

- A. General: This shall be a ceiling-concealed ducted indoor fan coil design that mounts above the ceiling with a 2-position, field adjustable return and a fixed horizontal discharge supply and shall have a modulating linear expansion device. The PEFY shall be used with the R2-Series outdoor unit and BC Controller, Y-Series outdoor unit, or S-Series outdoor unit. The PEFY shall support individual control using M-NET DDC controllers.
- B. Indoor Unit: The indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, electronic modulating linear expansion device, control circuit board and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, and an auto restart function. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory.
- C. Unit Cabinet:
 1. The unit shall be, ceiling-concealed, ducted.
 2. The cabinet panel shall have provisions for a field installed filtered outside air intake.
- D. Fan:
 1. Concealed ducted models shall feature external static pressure settings from 0.14 to 0.60 in. WG.
 2. The indoor unit fan shall be an assembly with one or two Sirocco fan(s) direct driven by a single motor.
 3. The indoor fan shall be statically and dynamically balanced and run on a motor with permanently lubricated bearings.
 4. The indoor fan shall consist of three (3) speeds, High, Mid, and Low plus the Auto-Fan function
 5. The indoor unit shall have a ducted air outlet system and ducted return air system.
- E. Filter:
 1. Return air shall be filtered by means of a standard factory installed return air filter.
 2. Optional return filter box (rear or bottom placement) with high-efficiency filter shall be available for all PEFY indoor units.
- F. Coil:
 1. The indoor coil shall be of nonferrous construction with smooth plate fins on copper tubing.
 2. The tubing shall have inner grooves for high efficiency heat exchange.
 3. All tube joints shall be brazed with phos-copper or silver alloy.
 4. The coils shall be pressure tested at the factory.
 5. A condensate pan and drain shall be provided under the coil.

6. The condensate shall be gravity drained from the fan coil.
 7. Both refrigerant lines to the PEFY indoor units shall be insulated.
- G. Electrical:
1. The unit electrical power shall be 208/230 volts, 1-phase, 60 hertz.
 2. The system shall be capable of satisfactory operation within voltage limits of 187-228 volts (208V/60Hz) or 207-253 volts (230V/60Hz).
- H. Controls:
1. This unit shall use controls provided by Mitsubishi Electric Cooling & Heating to perform functions necessary to operate the system. Please refer to Part 5 of this guide specification for details on controllers and other control options.
 2. Indoor unit shall compensate for the higher temperature sensed by the return air sensor compared to the temperature at level of the occupant when in HEAT mode. Disabling of compensation shall be possible for individual units to accommodate instances when compensation is not required.
 3. Control board shall include contacts for control of external heat source. External heat may be energized as second stage with 1.8°F – 9.0°F adjustable deadband from set point.
 4. Indoor unit shall include no less than four (4) digital inputs capable of being used for customizable control strategies.
 5. Indoor unit shall include no less than three (3) digital outputs capable of being used for customizable control strategies.
- I. Capacities and Characteristics: as scheduled on drawings.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install fan coil units level and plumb.
- B. Install fan coil units to comply with NFPA 90A.
- C. Suspend fan coil VRF units from structure with elastomeric hangers.
- D. Verify locations of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation. Install devices **48 inches (1220 mm)** above finished floor.
- E. Install new filters in each fan coil unit within two weeks after Substantial Completion.
- F. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties. Specific connection requirements are as follows:
 1. Install piping adjacent to machine to allow service and maintenance.
 2. Connect piping to fan coil unit factory DX piping package. Install piping package if shipped loose.

3. Connect ductwork to concealed units as required by MFR.
4. Connect condensate drain to indirect waste.
 - a. Install condensate trap of adequate depth to seal against fan pressure. Install cleanouts in piping at changes of direction.
- G. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."
- H. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

3.02 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections[with the assistance of a factory-authorized service representative]:
 1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 2. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.
- B. Remove and replace malfunctioning units and retest as specified above.
- C. Prepare test and inspection reports.

3.03 ADJUSTING

- A. Adjust initial temperature and humidity set points.
- B. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions.

END OF SECTION 23 82 19

SECTION 26 05 00.13**SYSTEMWIDE ELECTRICAL GENERAL REQUIREMENTS FOR SYSTEMS****PART 1 - GENERAL****1.1 SUMMARY**

- A. This Section covers general electrical requirements for furnishing and installation of embedded and exposed raceways, junction boxes, manholes, handholes, and ductbanks. This Work includes, but is not limited to, the following:
1. The installation of a mainline ductbank system located 24 inches from finished grade under the centerline of the track-slab. The configuration will consist of two-four inch schedule 40 polyvinyl chloride (PVC) and one multi-cell raceway with four-1 1/2" schedule 40 PVC conduits embedded in sand or Controlled Density Fill (CDF).
 2. The continuation of the mainline ductbank system across the Main Street Viaduct and Delaware bridge structures using three four inch FRE raceways attached to the bridge structure.
 3. The continuation of the mainline ductbank system across the I-670 bridge structure using three four inch PVC conduits embedded in the east sidewalk of the bridge.
 4. Embedded and exposed lateral raceways for Traction Electrification, Signal and Communication Systems located along and near the track alignment and station platforms.
 5. Embedded lateral raceway from platform communication handhole to future TVM location, and station marker.
 6. Embedded lateral raceway from platform communication handhole to shelter column for all platforms with shelters
 7. Embedded Signal/Communication manholes along the alignment located between track rails in the track-slab.
 8. Signal/Communication and Traction Electrification manholes along the alignment not in the track-slab.
 9. Testing of all systems that are installed under this Contract.

1.2 RELATED SECTIONS

- A. SECTION 01 33 00 – Submittal Procedures
- B. SECTION 01 78 39 – Project Record Documents

1.3 REFERENCES AND STANDARDS

- A. The Contractor shall comply with applicable standards as specified within these documents:
1. American National Standards Institute (ANSI)
 - a. ANSI/IEEE C2 National Electrical Safety Code

2. National Fire Protection Association (NFPA)
 - a. NFPA 70 National Electrical Code (NEC)
 - b. NFPA 101 Life Safety Code
3. National Electrical Manufacturers Association (NEMA)
 - a. NEMA 250 Enclosures for Electrical Equipment (1000 V Maximum)
 - b. NEMA KS1 Enclosed and Miscellaneous Distribution Equipment Switches (600 V Maximum)
 - c. NEMA WD1 General Color Requirements for Wiring Devices
4. Institute of Electrical and Electronics Engineers (IEEE)
5. National Electrical Contractors Association (NECA) Standard of Installation
6. National Electrical Testing Association (NETA)
7. Underwriters Laboratories (UL)
8. Insulated Cable Engineers Association (ICEA)
9. The Occupational Safety and Health Act (OSHA)
10. Standard for Fixed Guideway Transit and Passenger Rail Systems (NFPA-130)
11. International Building Code (IBC)
12. National, State and Local Construction Codes
13. National, State and Local Laws and Ordinances
14. Local Utility Requirements

1.4 QUALITY ASSURANCE

- A. Quality assurance planning, implementation and reporting shall be in conformance with Contract Documents.

1.5 SUBMITTALS

- A. SECTION 01 33 00 – Submittal Procedures..
- B. Items required to be submitted by the Contractor for Approval include, but are not limited to, the following:
 1. As-Built Drawings
 2. Shop drawings for the following equipment:
 - a. Manholes, Handholes, Frames and Covers
 - b. Raceways
 - c. Junction Boxes

3. Mandrel Log
 4. The Contractor shall submit the manufacturer's name, product designation and catalog numbers for testing equipment including calibration certification expiration date.
- C. Prior to submittal and at the engineer's discretion, all shop drawings shall be checked for accuracy and Contract requirements. Shop drawings shall bear the date checked. In addition, each shop drawing submitted shall include a copy of the applicable sections, with addendum updates included, with each paragraph check-marked to indicated specification compliance or marked to indicate requested deviations from specification requirements. Check marks shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated and upon request shall be submitted with each deviation underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of paragraph not underlined will signify compliance with the specifications. The submittal shall be accompanied by detailed written justification for each deviation. Failure to include a copy of the marked-up specification sections along with justifications for any requested deviations to the specification requirements with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
- D. Shop Drawings - Submit shop drawings showing equipment layouts and fabricated work being provided under these Specifications. Submit such drawings before rough-in work, fabrication, and within ample time to prevent delays in the Work. Include electrical diagrams for equipment and equipment installation.

1.6 GENERAL REQUIREMENTS

- A. Wherever the requirements of these Contract Documents exceed those of the governing codes and regulations, the requirements of these Contract Documents shall govern. Nothing in these Contract Documents shall be construed as relieving the Contractor from complying with any requirements of governing codes or regulations.
- B. All conflicts occurring between codes, regulations, and these Contract Documents will be resolved by the Engineer.
- C. Inspection
1. All materials, equipment, and workmanship are subject to inspection at any time by the Engineer. Any Work, materials or equipment not in accordance with the Contract or found to be deficient or defective shall be corrected by the Contractor at no additional cost to KCMO.
- D. Listing and Labeling
1. Electrical equipment and material shall be listed and labeled by organizations such as UL, which are acceptable to the authority having jurisdiction.

1.7 DEFINITIONS

- A. The following definitions shall apply:
1. "Furnish" means supply and delivery to the work site or location where material is to be installed.
 2. "Install" means build into the Work, complete and ready for use intended.
 3. "Provide" means furnish and install complete and ready for use intended.

4. "Contract Drawings" means drawings included in Contract Documents.
5. "Contract Specifications" means Specifications included in Contract Documents.

1.8 LICENSING AND CERTIFICATION REQUIREMENTS

- A. All Electrical Work installed shall be performed by licensed Electricians as applicable by State, county, or city law.

1.9 CONTRACT DRAWINGS AND CONTRACT DOCUMENTS

- A. Intent of Contract Drawings
 1. Verify all dimensions before proceeding with the Work.
 2. The electrical Contract Drawings do not indicate all fittings, hardware or appurtenances required for a complete operating installation.
 3. One-line and riser diagrams are schematic and do not show physical arrangement of equipment.
 4. Layout plans are diagrammatic, i.e. the location of the devices, ducts, and raceways are approximate. Contractor shall make minor field adjustment not deviating from codes, standards and typical details provided in the Contract Drawings. Prior to making any significant changes, the Contractor shall obtain Approval from the Engineer.
- B. Departures from Contract Documents
 1. Departures from the Contract Documents include any deviations from Contract Drawings, Contract Specifications, Contract Provisions, or General Provisions of the Contract.
 2. Departures from the Contract Documents shall not be made without a statement of "no objection" from the Engineer.
 3. Proposed departures shall be submitted to the Engineer in accordance with the procedures outlined under Contract Provisions, Change Orders in the Work, and General Provisions, Change Order Procedures.

1.10 PRODUCT SELECTION

- A. For products specified by referenced standards only, select any product meeting the referenced standards, by any manufacturer. Provide documentation with submittals demonstrating that the product meets the requirements of the referenced standards.
- B. For products specified by one or more manufacturer's name(s), whether or not followed by the words "or equal", select the specified product by one of the listed manufacturers, or submit a substitution request for any product or manufacturer not specifically named.

1.11 DELIVERY, STORAGE AND HANDLING

- A. Delivery, storage, and handling shall be carried out in accordance with the Contract Requirements.
- B. All material shall be delivered to the site in the manufacturers' original packing, except less than carton quantities may be repacked in other containers by the Contractor or the Contractor's suppliers.
- C. All material shall be stored in an environment recommended by the manufacturer of that product and in accordance with any additional requirements specified herein.

- D. All material shall be handled as recommended by the manufacturer of the product and in accordance with any additional requirements specified herein.
- E. Protection during construction
 - 1. Throughout this Contract, provide protection for materials and equipment against loss or damage.
 - 2. Protect materials and equipment from the effects of weather. Prior to installation, store items in clean, indoor and dry location. Items subject to corrosion under damp conditions and items containing insulation such as conductors shall be stored in a clean, indoor, heated and dry location.
 - 3. Following installation, protect materials and equipment from corrosion, dust, dirt, physical damage and the effects of moisture. Energize any space heaters in equipment or provide temporary heat. Cap raceway runs with manufactured seals. Keep openings in boxes or equipment closed during construction.

1.12 CODES, INSPECTIONS AND FEES

- A. The Contractor shall obtain all necessary permits, inspections, certificates of acceptance, certificates of occupancy, etc. Contractor shall pay all fees related to these items. Contractor shall submit to the authority having jurisdiction the necessary drawings in the size and quantity as required by the authority having jurisdiction. These permits, inspections, and certificates shall cover all aspects of the electrical system. The permits, inspections and certificates shall be obtained by contractor from the appropriate authority having jurisdiction including, but not limited to, building departments, inspection authorities, plan review examiners, fire marshals, insurers, etc
- B. The Contractor shall obtain required inspection stickers indicating installation suitability from the local authority having jurisdiction. Install as directed by authority having jurisdiction.

1.13 AS-BUILT DRAWINGS

- A. The Contractor shall maintain and keep current a set of project records and as-built Contract Drawings. In accordance with SECTION 01 78 39 – Project Record Documents, as-built drawings are to be submitted for Approval before project close-out.

PART 2 - PRODUCTS

2.1 GENERAL

- A. All material and products shall be new and unused.
- B. Provide materials and equipment that will fit within the space provided.
- C. Electrical equipment and material shall be listed and labeled by a nationally recognized electrical testing laboratory acceptable to the authority having jurisdiction.
- D. Where two or more units of the same class of material or equipment are required, provide products of a single manufacturer. Incidental component parts of equipment are not required to be the products of the same manufacturer.
- E. Provide materials and equipment that are standard products of manufacturers regularly engaged in the production of such material and equipment. Provide the manufacturer's latest standard design that conforms to these Specifications.

- F. Where the finish of equipment or material is referenced or stated, provide the finish exactly as shown or specified. Where no finish or color is listed, provide the manufacturer's standard finish, suitable for the environment intended.
- G. Material and equipment shall be designed to ensure satisfactory operation and operational life in the environmental conditions which will prevail where the material or equipment is installed.

PART 3 - EXECUTION

3.1 GENERAL

- A. The work under DIVISION 26 SYSTEMWIDE ELECTRICAL shall be performed in accordance with the NEC, local codes and regulations, manufacturers' recommendations and in accordance with these Specifications.
- B. The Engineer reserves the right to require minor changes in location of raceways without incurring any additional costs or charges to KCMO.
- C. Install Work using procedures defined in NECA Standard of Installation.
- D. Coordinate the Work of this Section with the other Sections of Division 26 as required to provide a complete and operable electrical installation.
- E. Coordinate also with the Sections for Signals, which require electrical equipment and services as part of the signal installation.
- F. Coordinate with work completed or in progress or to be performed under other Sections of these Specifications or by other contractors. Make indicated connections to previously completed work. Where future connections to or extensions of the work are indicated, provide safe and convenient provisions for such future connections and extensions.

3.2 TESTING

- A. Perform testing for all systems furnished under Division 26 as specified in each Section.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

- A. The quantities of accepted work will be measured in the following units. All measurements will be plan measure except for authorized changes.
 - 1. Description: Lump Sum

4.2 PAYMENT

- A. Payment will be made at the respective unit or lump-sum price listed in the proposal and shall be full compensation for all labor, materials, and equipment necessary to complete the respective unit in place. There will be no separate measurement or payment for any item of work not specifically identified and listed in the proposal, and all such work shall be considered a subsidiary item with all costs pertaining thereto included in the prices for other items listed in the proposal. At the Engineer's option, partial payment may be made for any lump sum item listed in the proposal, providing that the Contractor is diligently and satisfactorily pursuing full completion of such partially complete item in accordance with the approved job progress schedule.

END OF SECTION

SECTION 26 05 19.13**SYSTEMWIDE ELECTRICAL LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES FOR SYSTEMS****PART 1 - GENERAL****1.1 SUMMARY**

- A. This Work includes providing wire and cable rated 600 Volts, and associated splices and terminations for electrical systems.

1.2 RELATED SECTIONS

- A. SECTION 01 43 00 – Systems Quality Assurance
- B. SECTION 26 05 00.13 – Systemwide Electrical General Requirements for Systems
- C. SECTION 26 08 10 – Systemwide Electrical Testing for Systems

1.3 REFERENCES AND STANDARDS

- A. National Electrical Manufacturer's Association (NEMA)
 - 1. NEMA WC 70 Nonshielded 0-2kv Cables
- B. National Fire Protection Association (NFPA)
 - 1. NFPA 70 National Electrical Code (NEC)
- C. Underwriters Laboratory (UL)
 - 1. UL 493 Thermoplastic-Insulated Underground Feeder and Branch-Circuit Cables
- D. National Electrical Contractors Association (NECA)
 - 1. NECA 1 Standard Practices for Good Workmanship in Electrical Contracting

1.4 QUALITY ASSURANCE/QUALITY CONTROL

- A. Quality Assurance/Quality Control shall be carried out in accordance with the requirements of SECTION 01 43 00 – Systems Quality Assurance.

1.5 SUBMITTALS

- A. Submittals shall be made in accordance with the requirements of SECTION 26 05 00.13 – Systemwide Electrical General Requirements for Systems, except as modified herein.
- B. Items required to be submitted by the Contractor for Approval include, but are not limited to, the following:
 - 1. Product data on each type of wire and cable, including:
 - a. Manufacturer of the wire and cable
 - b. Number and size of strands composing each conductor

- c. Conductor insulation composition and thickness
 - d. Average overall diameter of finished wire and cable
 - e. Conductor ampacity at 60 degrees Celsius ambient for three current-carrying conductors in raceway or cable
 - f. Shield material (if any) and thickness
2. Product data on splicing and termination materials
 3. Field quality control test reports

1.6 DELIVERY, STORAGE AND HANDLING

- A. Ship each unit securely wrapped, packaged, and labeled for safe handling in shipment and to avoid damage.
- B. Store wire and cable in secure and dry storage facility, in accordance with NECA 1

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. All conductors shall be stranded. Size and type of insulation shall be as indicated.
- B. Minimum size – No. 12 AWG unless otherwise indicated.
- C. Wire and cable markings shall be in accordance with applicable NEMA and NEC requirements.

2.2 600 VOLT WIRE AND CABLE

- A. Subject to compliance with requirements, provide products by one of the following or approved equal:
 1. American Insulated Wire Corp; a Leviton Company
 2. General Cable Corporation
 3. Senator Wire and Cable Company
 4. Southwire Company
- B. All conductors shall be 99% conductivity copper with insulation rated 90 degrees Celsius, wet or dry.
- C. All wire and cable, including grounding conductors, shall have type XHHW-2 insulation, unless otherwise shown.
- D. Type USE (Underground Service Entrance) cable shall be in accordance to UL 493.

2.3 600 VOLT TERMINATIONS

- A. Terminations No. 8 and larger shall use tin or silver plated copper compression type lugs with NEMA bolt hole patterns as manufactured by Thomas and Betts, Burndy, or approved equal. Aluminum or aluminum alloy terminals shall not be used.

PART 3 - EXECUTION**3.1 GENERAL INSTALLATION REQUIREMENTS**

- A. Provide and install conductors of the sizes and types shown.
- B. Inspect all wire and cable for damage prior to installation. Damaged cable shall not be installed.

3.2 600 VOLT TERMINATIONS

- A. Soldering of conductors is not permitted.

3.3 COLOR CODING

- A. All wiring shall be color coded.
- B. 208Y/120V or 120/240V systems shall be A-phase black, B-phase red, C-phase blue, neutral white, and ground green.
- C. 277V/480V systems shall be A-phase brown, B-phase orange, C-phase yellow, neutral grey, and ground green.

3.4 TESTS

- A. Tests shall be performed in accordance with SECTION 26 08 10 – Systemwide Electrical Testing For Systems.

PART 4 - MEASUREMENT AND PAYMENT**4.1 MEASUREMENT**

- A. The quantities of accepted work will be measured in the following units. All measurements will be plan measure except for authorized changes.
 - 1. Description: Lump Sum

4.2 PAYMENT

- A. Payment will be made at the respective unit or lump-sum price listed in the proposal and shall be full compensation for all labor, materials, and equipment necessary to complete the respective unit in place. There will be no separate measurement or payment for any item of work not specifically identified and listed in the proposal, and all such work shall be considered a subsidiary item with all costs pertaining thereto included in the prices for other items listed in the proposal. At the Engineer's option, partial payment may be made for any lump sum item listed in the proposal, providing that the Contractor is diligently and satisfactorily pursuing full completion of such partially complete item in accordance with the approved job progress schedule.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 26 05 19**LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES****PART 1 - GENERAL****1.01 SUMMARY**

- A. This Section includes the following:
 - 1. Building wires and cables rated 600 V and less.
 - 2. Connectors, splices, and terminations rated 600 V and less.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

1.03 INFORMATIONAL SUBMITTALS

- A. Field quality-control test reports.

1.04 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.

PART 2 - PRODUCTS**2.01 CONDUCTORS AND CABLES**

- A. Copper Conductors: Comply with NEMA WC 70.
- B. Conductor Insulation: Comply with NEMA WC 70 for Types THHN-THWN.
- C. Multiconductor Cable: Comply with NEMA WC 70 for nonmetallic-sheathed cable, Type NM with ground wire.

2.02 CONNECTORS AND SPLICES

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. AFC Cable Systems, Inc.
 2. Hubbell Power Systems, Inc.
 3. O-Z/Gedney; EGS Electrical Group LLC.
 4. 3M; Electrical Products Division.
 5. Tyco Electronics Corp.
- B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

PART 3 - EXECUTION

3.01 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

3.02 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Service Entrance: Type THHN-THWN, single conductors in raceway.
- B. Exposed Feeders: Type THHN-THWN, single conductors in raceway.
- C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace: Type THHN-THWN, single conductors in raceway.
- D. Feeders Below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.
- E. Exposed Branch Circuits, Including in Crawlspace: Type THHN-THWN, single conductors in raceway.
- F. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway.
- G. Branch Circuits Concealed Below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.
- H. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.

- I. Class 1 Control Circuits: Type THHN-THWN, in raceway.
- J. Class 2 Control Circuits: Type THHN-THWN, in raceway.

3.03 INSTALLATION OF CONDUCTORS AND CABLES

- A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.
- B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- E. Support cables according to Division 26 Sections "Hangers and Supports for Electrical Systems."
- F. Identify and color-code conductors and cables according to Division 26 Section "Identification for Electrical Systems."
- G. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- H. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
- I. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.

3.04 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Division 26 Section "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.05 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
- B. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

- C. Test Reports: Prepare a typed report to record the following:
1. Test procedures used.
 2. Test results that comply with requirements.
 3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.
- D. Remove and replace malfunctioning units and retest as specified above.
- E. Provide a copy of the Meg readings of all electrical cables to design professional for review and comment. If any current leakage is found from the Meg reading, it must be corrected.

END OF SECTION 26 05 19

SECTION 26 05 26.13**SYSTEMWIDE ELECTRICAL GROUNDING FOR SYSTEMS****PART 1 - GENERAL****1.1 SUMMARY**

- A. This Work includes providing ground cables and wires, bonding wires and cables, ground rods, exothermic welds, ground lugs and fittings for all manholes as required by the National Electrical Code (NEC), these Specifications, and the Drawings. Grounding requirements for Overhead Contact System (OCS) poles, and signal houses shall be found in their respective Systems Specifications. Fence and gate grounding shall be found in the Civil Design Drawings.

1.2 RELATED SECTIONS

- A. SECTION 26 05 00.13 – Systemwide Electrical General Requirements for Systems

1.3 REFERENCES AND STANDARDS

- A. American Society for Testing and Material (ASTM)
 - 1. ASTM B3 Specifications for Soft or Annealed Copper Wire
 - 2. ASTM B187 Copper Bus Bar, Rod and Shapes
- B. National Fire Protection Association (NFPA)
 - 1. NFPA 70 National Electrical Code (NEC)

1.4 QUALITY ASSURANCE/QUALITY CONTROL

- A. Quality Assurance/Quality Control shall be in accordance with the requirements of the Special Conditions.

1.5 SUBMITTALS

- A. The Contractor shall submit test reports in conformance with SECTION 26 05 00.13 – Systemwide Electrical General Requirements for Systems, and the Contract requirements.
- B. Items required to be submitted by the Contractor for Approval include, but are not limited to the following:
 - 1. Product data on exothermic welding process, materials and molds
 - 2. Product data on grounding and bonding conductors
 - a. Product data on connectors, bushings and fittings
 - b. Product data on ground rods
- C. Provide test reports in accordance with the requirements of SECTION 26 05 00.13 – Systemwide Electrical General Requirements for Systems.
- D. Shop Drawings: Where grounding system is not detailed on the Contract Drawings, submit shop drawings showing locations of ground rods and grounding connections.. Drawings shall also indicate locations of test points to measure grounding resistance.

1.6 AS-BUILT DRAWINGS

- A. As-built drawings of all grounding systems as actually installed under this Contract shall be provided in accordance with SECTION 26 05 00.13 – Systemwide Electrical General Requirements for Systems.

1.7 DELIVERY, STORAGE AND HANDLING

- A. Ship each item of equipment and materials securely wrapped, packaged, and labeled for safe handling in shipment and to avoid damage.
- B. Store equipment and materials in secure and dry storage facility in accordance of SECTION 26 05 00.13 – Systemwide Electrical General Requirements for Systems.

PART 2 - PRODUCTS**2.1 BASIC GROUNDING MATERIALS**

- A. Bare conductors shall be “Class B” stranded, annealed copper, and conform to ASTM B3. Provide the size shown on the Contract Drawings. Aluminum conductors shall not be used.
- B. Single insulated conductors shall conform to the requirements of the NEC for 600 Volt insulated conductors. Provide green insulation for conductors No. 2 AWG or smaller and black insulation with ends green taped for larger sizes.
- C. Ground rods shall be steel with copper-cladding applied by the molten weld casting process. Use 3/4-inch diameter by 10 foot long rods with 10 mils minimum copper thickness except where otherwise indicated.
- D. Bus bar shall conform to ASTM B187, 99% conductivity copper, size as shown on the Contract Drawings.
- E. Lugs shall be suitable for attaching a ground conductor to equipment or metallic surfaces, and shall be NEMA two-hole, compression type, tin or silver plated copper, hydraulic tool applied, as manufactured by Thomas and Betts, Burndy, or approved equal.
- F. Bolts and miscellaneous hardware for grounding shall be silicon bronze or stainless steel.
- G. Jumpers shall be tin-plated copper, braided and flexible.
- H. Compression connectors for grounding in above ground dry locations, shall be Burndy YG Series, or approved equal.
- I. Mechanical connectors for grounding above ground in dry locations, and for attachment to equipment, boxes, or finished electrical products, shall be Burndy GB, GC, or approved equal.
- J. Connection to fence post above ground shall be Burndy GD or approved equal.

2.2 EXOTHERMIC WELDING PROCESS

- A. Exothermic welding process shall consist of a system of standard manufactured molds for each type of weld to be made and powdered metals, which are placed in the mold along with the conductors to be welded. Ignition of the powder shall produce molten copper which welds the conductors to each other and to a surface, as the case may be. Exothermic materials and products shall be Cadweld as manufactured by ERICO Products, Inc., Thermoweld, or approved equal.

PART 3 - EXECUTION**3.1 GENERAL GROUNDING REQUIREMENTS**

- A. Provide all grounding as specified and shown in the Contract Documents.
- B. Unless otherwise indicated, all underground grounding connections shall be by exothermic welding. Unless otherwise indicated, all connections located outdoors, or above ground in damp, or wet locations shall be by exothermic welding. Grounding connections shall not be soldered. Compression type grounding will be allowed only in station platforms upon Engineer's approval.
- C. Grounding conductors shall be protected from physical and environmental damage. Wherever possible, grounding electrode and bonding conductors shall be enclosed in a non-metallic raceway. Exposed conductors which must extend from a concrete surface shall be located as close as possible to a corner. Where conductors are required to be exposed, as in the connection to the main ground bus, grounding conductors shall be supported by corrosion resistant metallic hardware at 4-foot intervals or less.
- D. Oxide inhibiting compound shall be used for all mechanical connections where copper to aluminum or copper to steel connections are made. The compound shall be applied to all copper, aluminum, and steel parts. In addition, all aluminum contact surfaces shall be abraded after application of the inhibiting compound, and before attachment of the bolted connection.
- E. All metallic objects within 15 feet of the centerline of nearest rail and outside the platform boundaries shall be grounded and the ground resistance shall not exceed 25 Ohms.

3.2 RACEWAY GROUNDING

- A. All metallic raceway systems shall be bonded together to provide a continuous electrical ground path. Metallic raceways shall be bonded to other raceway components using insulated grounding bushings. Grounding bushings shall be connected to the grounding system using conductors sized in compliance with the NEC and as otherwise shown.

3.3 GROUND RODS

- A. Provide and install ground rods where shown on the Contract Documents. Connect the grounding conductor to each ground rod using exothermic welds.
- B. Bury ground rods vertically with rod top a minimum of 2 feet below grade. If extensive rock formation is encountered, the Contractor shall inform the Engineer and relocate ground rods, or provide supplemental ground rods as directed by the Engineer. If in bedrock, drill a 6-inch diameter hole for each ground rod, pack with clay and install the ground rod.
- C. Ground rods shall be installed in undisturbed earth.
- D. Install supplemental ground rods only as needed in addition to the grounding system as shown or specified, to make the grounding system conform to the required test results.

3.4 EXOTHERMIC WELDING

- A. The surface to be welded shall be clean and dry. Wire brush or file the point of contact to a clean bare metal surface.
- B. Use welding cartridges and molds for the type of weld shown on the Contract Documents, and perform welding in accordance with the manufacturer's recommendations. Worn or damaged molds shall not be used.

- C. After welds have been completed and cooled, brush slag from the weld area and thoroughly clean the joint.
- D. Where exothermic grounding connections made between copper wire and steel surfaces are directly buried, coat the connection with a coal tar epoxy coating per manufacturers recommendations before backfilling. Also coat the entire area of the steel surface disturbed by the exothermic welding.
- E. Unless otherwise indicated, use exothermic welding for all underground cable to cable splices, tees, crosses, etc and all cable connections to ground rods, ground rod splices, cable to steel and cast iron, and underground cable lug terminations.
- F. Test all welds by striking with a 2-pound steel hammer. Replace any defective weld and molds.
- G. Where exothermic welds are made to a galvanized surface, remove the galvanizing using a grinding wheel to expose a clean surface. After welding, touch up the steel surface with zinc rich primer.
- H. Exposed exothermic welds associated with the OCS grounding conductor on the bridges shall be wrapped with 2kV insulating tape.

3.5 INSPECTION AND TESTS

- A. Perform grounding tests of the completed ground system.
- B. Notify the Engineer prior to backfilling or pouring concrete over grounding connections, a ground mat, or a grounding system. Place no backfill or concrete until inspection and Approval by the Engineer.
- C. Test the continuity and resistance prior to backfilling or pouring concrete.
- D. Test the grounding and bonding continuity of each equipment and device installed.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

- A. The quantities of accepted work will be measured in the following units. All measurements will be plan measure except for authorized changes.

1. Description: Lump Sum

4.2 PAYMENT

- A. Payment will be made at the respective unit or lump-sum price listed in the proposal and shall be full compensation for all labor, materials, and equipment necessary to complete the respective unit in place. There will be no separate measurement or payment for any item of work not specifically identified and listed in the proposal, and all such work shall be considered a subsidiary item with all costs pertaining thereto included in the prices for other items listed in the proposal. At the Engineer's option, partial payment may be made for any lump sum item listed in the proposal, providing that the Contractor is diligently and satisfactorily pursuing full completion of such partially complete item in accordance with the approved job progress schedule.

END OF SECTION

SECTION 26 05 26**GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS**

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Grounding systems and equipment.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

1.03 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.04 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.01 CONDUCTORS

- A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
- B. Bare Copper Conductors:
 - 1. Solid Conductors: ASTM B 3.
 - 2. Stranded Conductors: ASTM B 8.
 - 3. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
 - 4. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
 - 5. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
 - 6. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

2.02 CONNECTORS

- A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.
- B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, pressure type with at least two bolts.
 - 1. Pipe Connectors: Clamp type, sized for pipe.
- C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.03 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad steel; 3/4 inch by 10 feet in diameter.

PART 3 - EXECUTION

3.01 APPLICATIONS

- A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.
- B. Underground Grounding Conductors: Install bare copper conductor, No. 2/0 AWG minimum. Bury at least 24 inches below grade.
- C. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.
- D. Conductor Terminations and Connections:
 - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
 - 2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
 - 3. Connections to Structural Steel: Welded connectors.

3.02 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:

PART 4 - Retain applicable subparagraphs below.

- 1. Feeders and branch circuits.

2. Lighting circuits.
 3. Receptacle circuits.
 4. Single-phase motor and appliance branch circuits.
 5. Three-phase motor and appliance branch circuits.
 6. Flexible raceway runs.
 7. Armored and metal-clad cable runs.
 8. Computer and Rack-Mounted Electronic Equipment Circuits: Install insulated equipment grounding conductor in branch-circuit runs from equipment-area power panels and power-distribution units.
- B. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.
- C. Water Heater, Heat-Tracing, and Anti-frost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.
- D. Signal and Communication Equipment: In addition to grounding and bonding required by NFPA 70, provide a separate grounding system complying with requirements in TIA/ATIS J-STD-607-A.
1. For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
 2. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-4-by-12-inch grounding bus.
 3. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

4.02 INSTALLATION

- A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- B. Ground Rods: Drive rods until tops are 2 inches below finished floor or final grade unless otherwise indicated.
1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
- C. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.
1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.

2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.

D. Grounding and Bonding for Piping:

1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
3. Bond each above ground portion of gas piping system downstream from equipment shutoff valve.

E. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install bonding jumper to bond across flexible duct connections to achieve continuity.

4.03 LABELING

- A. Comply with requirements in Division 26 Section "Identification for Electrical Systems" Article for instruction signs. The label or its text shall be green.
- B. Install labels at the telecommunications bonding conductor and grounding equalizer and at the grounding electrode conductor where exposed.
 1. Label Text: "If this connector or cable is loose or if it must be removed for any reason, notify the facility manager."

4.04 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections and prepare test reports:
 1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
 2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
 3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal. Make tests at ground rods before any conductors are connected.

PART 5 - See Division 01 Section "Quality Requirements" for retesting and reinspecting requirements and Division 01 Section "Execution" for requirements for correcting the Work.

- A. Excessive Ground Resistance: If resistance to ground exceeds 5 ohms, notify Design Professional promptly and include recommendations to reduce ground resistance.

END OF SECTION 26 05 26

SECTION 26 05 29.13**SYSTEMWIDE ELECTRICAL RACEWAY AND EQUIPMENT SUPPORTS FOR SYSTEMS****PART 1 - GENERAL****1.1 SUMMARY**

- A. This Work includes providing complete raceway and equipment supports as shown and as specified.
- B. Construction requirements for concrete bases

1.2 RELATED SECTIONS

- A. SECTION 26 05 00.13 – Systemwide Electrical General Requirements for Systems
- B. SECTION 03 30 00 – Cast-in-place Concrete

1.3 REFERENCED STANDARDS

- A. American Welding Society (AWS)
 - 1. AWS D1.1/D1.1M Structural Welding Code - Steel
- B. SMACMA - Seismic Restraint Manual - Guidelines for Mechanical Systems
- C. National Fire Protection Agency (NFPA)
 - 1. NFPA 70 National Electrical Code (NEC)
- D. American Society for Testing and Materials (ASTM)
 - 1. ASTM A325 Standard Specification For Structural Bolts, Steel, Heat Treated, 120/105 KSI Minimum Tensile Strength
 - 2. ASTM A780 Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
- E. Society for Protective Coatings (SSPC)
 - 1. SSPC PA 1 Shop, Field, and Maintenance Painting of Steel
- F. National Electrical Contractors Association (NECA)
 - 1. NECA 1 Standard Practice of Good Workmanship in Electrical Contracting
 - 2. NECA 101 Standard for Installing Steel Conduits (Rigid, IMC, EMT)

1.4 QUALITY ASSURANCE

- A. Qualify procedures and personnel according to AWS D1.1/D1.1M
- B. Comply with NFPA 70.

1.5 SUBMITTALS

- A. Submittals shall be made in accordance with the requirements of SECTION 26 05 00.13 – Systemwide Electrical General Requirements, except as modified herein.
- B. Items required to be submitted by the Contractor for Approval include, but are not limited to, the following:
 - 1. Product data on concrete expansion anchors
 - 2. Product data on channel system, including clamps and fittings
 - 3. Product data on concrete inserts
 - 4. Product data on trapeze hangers
 - 5. Product data on equipment supports
 - 6. Anchor bolt calculations
- C. Welding certificates

PART 2 - PRODUCTS

2.1 SEISMIC DESIGN

- A. All equipment and conduits shall be adequately restrained and supported to resist seismic forces. Restraint devices shall be designed and selected to meet seismic requirements as defined in the latest issue of the International Building Code, and applicable State and Local codes.
- B. Anchor bolt calculations, signed and stamped by a Professional Engineer registered in the State of Missouri, shall be submitted showing required bolt numbers, sizes, types, and spacing. Stamped calculations shall also be furnished for anchors on restraint devices, cables, isolators, and rigidly mounted equipment.

2.2 RACEWAY SUPPORTS

- A. Raceway clamps shall be bolted type, hot-dip or mechanically galvanized one hole, heavy gauge steel, or galvanized malleable iron with clamp back. Caddy Clips shall not be used.
- B. Hanger rod shall be galvanized steel or electro-galvanized and zinc chromate coated steel, 3/8-inch diameter minimum.
- C. Channels and channel fittings, and clamps and accessories, shall be hot-dip galvanized steel. Channels shall be 14-gauge minimum, 1-5/8 inch deep by 1-5/8 inch wide minimum. Channel system shall be by Unistrut, Powerstrut, B-Line, O-Strut, or approved equal.
- D. Where heavy-duty racks are required, channel shall be 12-gauge, 1-5/8 inch deep by 1-5/8 inch wide minimum. Channel, raceway clamps and accessories shall be hot-dip galvanized steel. Aluminum, and light gauge strength metals or materials shall not be used.

2.3 ANCHORS

- A. Provide anchors with sufficient strength to support four times the load.
 - 1. Hollow Masonry – Toggle bolt type expansion anchors

2. Solid Masonry – Concrete expansion anchors
3. Metal Surfaces – Machine screws, bolts or welded studs
4. Wood Surfaces – Wood screws or lag bolts
5. Concrete Surfaces – Concrete expansion anchors shall be wedge type and shall be Phillips Red-Head, Hilti, or approved equal
6. Powder driven studs shall not be used

2.4 CONCRETE INSERTS

- A. Continuous slot-channel inserts shall be fabricated from 12-gauge steel, rated for loads of 2,400 pounds per foot, Unistrut, Allied Powerstrut or approved equal.
- B. Spot inserts shall be rated for a load of 1,000 pounds or greater each, Unistrut, Allied Powerstrut or approved equal.
- C. Finish shall be hot-dip galvanized.

2.5 FASTENERS AND HARDWARE

- A. Fasteners and hardware shall be suitable for the use and environment intended. All fasteners shall be corrosion resistant, protected by hot-dip galvanizing after fabrication or stainless steel. Unplated steel shall not be used. Caddy Clips shall not be used.
- B. Provide stainless steel fasteners in manholes, handholes or splice boxes, where exposed to weather, or in damp or wet locations.

PART 3 - EXECUTION

3.1 INSTALLATION OF RACEWAY RACKS

- A. Multiple runs of exposed raceway shall be grouped and supported on raceway racks constructed from channels, raceway clamps and fittings. Caddy Clips shall not be used. Raceway racks shall be trapeze style constructed from steel channels, supported by 3/8-inch or 1/2-inch rods and concrete expansion anchors.
- B. Provide raceway rack as indicated and with a minimum of 25% spare capacity.
- C. Raceway racks may be used for support of vertical or horizontal raceway runs, except where otherwise specified.
- D. Where raceways 2 inches or larger are supported by racks, use heavy-duty channel clamps and accessories.

3.2 INSTALLATION OF CONCRETE EXPANSION ANCHORS

- A. Concrete expansion anchors shall be used wherever a bolted attachment to concrete is required. Holes for anchors shall be driven perpendicular to the concrete surface, and the anchor installed in accordance with manufacturer's instructions.
- B. Anchors installed at an angle to the surface, or anchors protruding from the surface, shall be replaced.
- C. Anchors shall not be spaced closer than six times the diameter of the hole, center to center.

3.3 INSTALLATION OF CONCRETE INSERTS

- A. Concrete inserts may be installed for supporting raceway and equipment wherever concrete anchors are required.
- B. Inserts may be inspected by the Engineer at his/her option before concrete is poured. Notify the Engineer 7 days in advance of pouring.

3.4 INSTALLATION OF FASTENERS AND HARDWARE

- A. Install fasteners and hardware suitable for the environment and use intended. Caddy Clips shall not be used. Where fasteners exhibit corrosion, replace at no additional cost to KCMO.

3.5 INSTALLATION OF SEISMIC BRACING

- A. Provide seismic restraints, supports, and attachments in accordance with Seismic Hazard Level (SHL) "B" as recommended in the *Seismic Restraint Manual: Guidelines for Mechanical Systems* (SMACMA), latest Edition.
- B. Design and obtain approval of seismic design from the authority having jurisdiction over seismic restraint hangers and supports for conduits and equipment.

PART 4 - MEASUREMENT AND PAYMENT**4.1 MEASUREMENT**

- A. The quantities of accepted work will be measured in the following units. All measurements will be plan measure except for authorized changes.
 - 1. Description: Lump Sum

4.2 PAYMENT

- A. Payment will be made at the respective unit or lump-sum price listed in the proposal and shall be full compensation for all labor, materials, and equipment necessary to complete the respective unit in place. There will be no separate measurement or payment for any item of work not specifically identified and listed in the proposal, and all such work shall be considered a subsidiary item with all costs pertaining thereto included in the prices for other items listed in the proposal. At the Engineer's option, partial payment may be made for any lump sum item listed in the proposal, providing that the Contractor is diligently and satisfactorily pursuing full completion of such partially complete item in accordance with the approved job progress schedule.

END OF SECTION

SECTION 26 05 29**HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS**

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Hangers and supports for electrical equipment and systems.
 - 2. Construction requirements for concrete bases.

1.02 PERFORMANCE REQUIREMENTS

- A. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- B. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

1.03 ACTION SUBMITTALS

- A. Product Data: For steel slotted support systems.
- B. Shop Drawings: Show fabrication and installation details and include calculations for the following:
 - 1. Trapeze hangers. Include Product Data for components.
 - 2. Steel slotted channel systems. Include Product Data for components.
 - 3. Equipment supports.

1.04 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

1.05 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.01 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Allied Tube & Conduit.
 - b. Cooper B-Line, Inc.; a division of Cooper Industries.
 - c. ERICO International Corporation.
 - d. GS Metals Corp.
 - e. Thomas & Betts Corporation.
 - f. Unistrut; Tyco International, Ltd.
 3. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
 4. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
 5. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
 6. Channel Dimensions: Selected for applicable load criteria.
- B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
- C. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.
- E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened Portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 - a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

- 1) Hilti Inc.
 - 2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
 - 3) MKT Fastening, LLC.
 - 4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.
2. Mechanical-Expansion Anchors: Insert-wedge-type, steel, for use in hardened Portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
- a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Cooper B-Line, Inc.; a division of Cooper Industries.
 - 2) Empire Tool and Manufacturing Co., Inc.
 - 3) Hilti Inc.
 - 4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
 - 5) MKT Fastening, LLC.
3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
6. Toggle Bolts: All-steel springhead type.
7. Hanger Rods: Threaded steel.

2.02 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
- B. Materials: Comply with requirements in Division 05 Section "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.01 APPLICATION

- A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.
- B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.
- C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with two-bolt conduit clamps.
- D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.02 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.
- B. Raceway Support Methods: In addition to methods described in NECA 1, EMT and RMC may be supported by openings through structure members, as permitted in NFPA 70.
- C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.
- D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
1. To Wood: Fasten with lag screws or through bolts.
 2. To New Concrete: Bolt to concrete inserts.
 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 4. To Existing Concrete: Expansion anchor fasteners.
 5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
 6. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.
 7. To Light Steel: Sheet metal screws.
 8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.
- E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.03 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Division 05 Section "Metal Fabrications" for site-fabricated metal supports.

- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M.

3.04 CONCRETE BASES

- A. Construct concrete bases of dimensions indicated but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.
- B. Use 3,000-psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 03 Section "Cast-in-Place Concrete."
- C. Anchor equipment to concrete base.
 - 1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 2. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.05 PAINTING

- A. Touchup: Comply with requirements in Division 09 painting Sections for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 26 05 29

SECTION 26 05 33.13**SYSTEMWIDE ELECTRICAL RACEWAYS FOR SYSTEMS****PART 1 - GENERAL****1.1 SUMMARY**

- A. This Work includes providing complete raceway systems as shown and as specified. Raceways assembled into ductbanks shall also meet the requirements of SECTION 26 05 43 – Systemwide Electrical Underground Ductbanks for Systems.
- B. This Section specifies the requirements for coating of metallic conduits.

1.2 RELATED SECTIONS

- A. SECTION 26 05 00.13 – Systemwide Electrical General Requirements for Systems
- B. SECTION 26 05 43 – Systemwide Electrical Underground Ductbanks for Systems
- C. SECTION 31 23 33 – Utility Trenching and Backfilling
- D. SECTION 01 43 00 – Systems Quality Assurance

1.3 REFERENCES AND STANDARDS

- A. American National Standards Institute (ANSI)
 - 1. ANSI C80.1 Specifications for Rigid Steel Conduit, Zinc Coated
- B. National Electrical Manufacturers Association (NEMA)
 - 1. NEMA RN 1 PVC Externally-Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit
 - 2. NEMA TC2 Electrical Plastic Tubing (EPT) and Conduit (EPC 40 and EPC 80)
 - 3. NEMA TC3 PVC Fittings for Use with Rigid PVC Conduit and Tubing
- C. National Fire Protection Association (NFPA)
 - 1. NFPA 70 National Electrical Code (NEC)
- D. Underwriter's Laboratories (UL)
 - 1. UL 651B Continuous Length HPDE Conduit
- E. American Society for Testing and Materials
 - 1. ASTM D1248 Standard Specification for Polyethylene Plastics Extrusion Materials For Wire and Cable
 - 2. ASTM D2239 Standard Specification for Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter
 - 3. ASTM D2447 Standard Specification for Polyethylene (PE) Plastic Pipe, Schedule 40 and 80, based on outside diameter

4. ASTM D3035 Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter
5. ASTM D3350 Standard Specification for Polyethylene Plastics Pipe and Fittings Materials

1.4 QUALITY ASSURANCE

- A. Comply with NFPA 70.
- B. Quality assurance planning, implementation and reporting shall be in conformance with SECTION 01 43 00 – Systems Quality Assurance, except as modified herein.

1.5 SUBMITTALS

- A. Submittals shall be made in accordance with the requirements of SECTION 26 05 00.13 – Systemwide Electrical General Requirements For Systems, except as modified herein.
- B. Items required to be submitted by the Contractor for Approval include, but are not limited to, the following:
 1. Product data on raceways
 2. Product data on fittings
 3. Product data on metallic joint compounds, caulking and sealing compounds
 4. Product data on pull cords
 5. Product data on raceway tags and labels
 6. Product data on conduit mandrels and brushes
 7. Product data on warning tape
 8. Product data on polyvinyl chloride (PVC) conduit joint cleaning solvent and cement
 9. Product data on PVC/GRSC (galvanized rigid steel conduit) coating patching compound

PART 2 - PRODUCTS

2.1 GALVANIZED RIGID STEEL CONDUIT (GRSC)

- A. Conduit shall comply with ANSI C80.1 and shall be hot-dip galvanized inside and out. Threaded ends shall be galvanized using a zinc metallizing process which sprays or blasts molten or semi-molten zinc on the threaded area. Minimum size shall be 3/4-inch.
- B. Approved manufacturers are LTV, Triangle, Allied or approved equal.

2.2 PVC SCHEDULE 40 CONDUIT (PVC)

- A. Conduit shall comply with NEMA TC 2, rigid polyvinyl chloride, Schedule 40. Conduit shall be sunlight resistant and suitable for 90 degrees Celsius conductors and exposed locations. Minimum size shall be 1 inch.
- B. Approved manufacturers are Carlon, PW Pipe, Western Plastics or approved equal.

2.3 PVC SCHEDULE 80 CONDUIT (PVC 80)

- A. Conduit shall comply with NEMA TC 2, rigid polyvinyl chloride, Schedule 80. Conduit shall be sunlight resistant and suitable for 90 degrees Celsius conductors and exposed locations. Minimum size shall be 2 inches.
- B. Approved manufacturers are Carlon, PW Pipe, Western Plastics or approved equal.

2.4 PVC COATED GALVANIZED RIGID STEEL CONDUIT (PVC/GRSC OR PGRSC)

- A. Conduit shall comply with ANSI C80.1 and NEMA RN 1, and shall be hot-dipped galvanized inside and out. Threaded ends shall be galvanized using a zinc metalizing process which sprays or blasts molten or semi-molten zinc on the threaded area. Minimum size shall be 3/4-inch.
- B. The galvanized surface shall be coated with an epoxy-acrylic primer to insure a bond between steel and plastic.
- C. The plastic coating on the exterior of conduit shall be applied by the plastisol method, to 40 mils minimum thickness.

2.5 PVC SCHEDULE 40 MULTI-CELL CONDUIT (QUAD-DUCT)

- A. The multicelled conduit system shall consist of four schedule 40 PVC color-coded conduits and shall be as follows:
 - 1. Nominal size of 1 ½ inches.
 - 2. Nominal I.D. of 1.57 inches.
 - 3. Maximum O.D. of 1.91 inches.
 - 4. Supplied in straight four-way lengths of 10 or 20 feet.
 - 5. Colors: Grey, White, Blue, and Orange.
 - 6. Smooth walled inside and outside.
 - 7. Each conduit shall have a ¼ inch rope installed by the manufacturer.
- B. The conduit system shall be a complete system with all the following fittings:
 - 1. Bell ends.
 - 2. Manhole terminator rings.
 - 3. Conduit spacers.
 - 4. Fixed elbows of radius shown in Table C of 26 05 33.
 - 5. Fixed elbows shall be offered in 11 ¼, 22 ½, 45, and 90 degree bends.
 - 6. Conduit duct plugs shall be installed on empty ducts.
- C. Conduit system shall be installed according to the manufacturer's instructions.
- D. Approved manufacturers are Carlon Intra-Gard Multi-Duct Raceway, or approved equal.

2.6 GRSC CONDUIT FITTINGS

- A. Conduit fittings shall be steel or cast malleable iron and shall be hot-dip or mechanically galvanized. Die-cast zinc fittings shall not be used.
- B. Bushings and grounding bushings shall have molded phenolic or nylon insulating collars. Grounding bushings shall have a "lay-in" tin-plated copper lug.
- C. Expansion fittings for exposed conduit runs shall be weatherproof with external bonding jumper, providing up to 4 inches longitudinal movement with bushed conduit ends.
- D. Deflection/Expansion fittings for exposed conduit shall be weatherproof, providing up to 30 degrees of deflection from the normal in all directions.
- E. Watertight split couplings or three-piece ('Ericson') couplings shall be O-Z/Gedney, or approved equal.
- F. Running thread or set screw type fittings shall not be used.
- G. Locknuts 2 inches and smaller shall be heavy galvanized steel. Locknuts larger than 2 inches shall be galvanized malleable iron.
- H. Hubs shall be galvanized steel or galvanized malleable iron, with insulating inserts and sealing rings. Hubs shall provide watertight conduit connections to boxes and enclosures.
- I. Conduit outlet bodies shall be cast ferrous alloy, with gasketed ferrous alloy cover, hot-dip or mechanically galvanized. Aluminum or aluminum alloy conduit bodies are not acceptable. "Short" conduit bodies such as SLB's are not acceptable. Acceptable manufacturers are O-Z/Gedney, Crouse-Hinds, Appleton or approved equal.

2.7 PVC COATED GALVANIZED RIGID STEEL CONDUIT FITTINGS

- A. Fittings for PVC/GRSC (PGRS) shall be by the same manufacturer and specifications as for PVC/GRSC conduit.

2.8 PVC CONDUIT FITTINGS

- A. Fittings for PVC conduit shall comply with NEMA TC 3. PVC conduit fittings shall be of the same manufacturer and type as the conduit.
- B. Expansion fittings shall be Carlon E945 Series, or approved equal.

2.9 RACEWAY TAGS AND LABELS FOR ABOVE GRADE RACEWAYS

- A. Tags and labels shall be made from nonferrous metals with raceway designations stamped by steel dies. This does not apply to conduits in ductbank.

2.10 CONDUIT MANDRELS AND BRUSHES

- A. Conduit brushes shall use round wire bristles for maximum cleaning of sand, grit, and obstructions from the conduit. They shall have a pulling eye on one end, and a smaller twisted eye on the other end, which shall allow for bi-directional pulling. Conduit brushes shall be sized as shown in Table A.

**TABLE A
CONDUIT BRUSH SIZES**

Duct Size (inches)	Diameter (inches)	Working Load (pounds)
2.0	1.87	200
2.5	2.38	200
3.0	2.87	200
3.5	3.38	200
4.0	3.87	200
5.0	4.87	200
6.0	5.87	200

- B. Conduit mandrels shall be flexible, and manufactured for cleaning out mud, dirt and light obstacles from ducts before the installation of cable. Mandrels shall be suitable for pulling around tight bends, and use a tapered profile which allows pulling in either direction. Pulling eyes shall be furnished on each end. The mandrel shall be fabricated from polyurethane, or an approved equal material, and shall not damage conduit inner walls. Conduit mandrels shall be sized per Table B or as Approved by the Engineer.

**TABLE B
CONDUIT MANDREL SIZES**

Duct Size (inches)	Diameter (inches)	Working Load (pounds)
2.0	1.88	2,330
2.5	2.19	2,330
3.0	2.81	2,330
3.5	3.25	4,800
4.0	3.75	4,800
5.0	4.69	4,800
6.0	5.81	4,800

- C. Conduit brushes and mandrels shall be manufactured for the purpose by a company regularly engaged in the production of electrical equipment, Greenlee Textron, Inc., or approved equal. Mandrels shall not be fabricated by the Contractor in the shop or field.

2.11 WARNING TAPE

- A. Tape shall be heavy-gauge, yellow and plastic for direct burial, 6-inch minimum width for use in trenches containing electric circuits. Tape shall be made of material resistant to corrosive soil. Tape shall have printed warning that an electric circuit is located below the tape. Approved manufacturers and types are ITT Blackburn Type YT, Griffolyn Co., Terra-Tape or approved equal.

2.12 DIRECTIONAL BORING

- A. General – Directional boring equipment shall consist of a directional boring rig of sufficient capacity to perform the bore and pull back the pipe, a boring fluid mixing and delivery system of adequate capacity to successfully complete the crossing, a guidance system to accurately guide boring operations and trained and competent personnel to operate the system.
- B. Boring System – The directional boring machine shall consist of a hydraulically powered system to rate, push and pull hollow drill pipe into the ground at a variable angle while delivering a pressurized fluid mixture to a guidable drill head. The machine shall be anchored to the ground to withstand the pulling, pushing and rotating pressure required to complete the crossing. Hydraulic systems shall be free of leaks. Rig shall have a system to monitor and record maximum pull-back pressure during pull-back operations. The rig shall be grounded during boring and pull-back operations.
- C. Bore head – The bore head shall be steerable by changing its rotation and shall provide the necessary cutting surfaces and boring fluid jets.
- D. Mud motors (if required) – Mud motors shall be of adequate power to turn the required boring tools.
- E. Drill Pipe – Pipe shall be constructed of high quality 4130 seamless tubing, grade D or better, with threaded box and pins. Tool joints should be hardened to 32-36RC.
- F. Guidance System – System shall be of a proven type and shall be setup and operated by personnel trained and experienced with this system. The operator shall be aware of any magnetic anomalies and shall consider such influences in the operation of the guidance system if using a magnetic system
- G. Boring Fluid (Mud) System
 - 1. Mixing System – A self-contained, closed, boring fluid mixing system shall of sufficient size to mix and deliver boring fluid composed of bentonite clay, potable water and appropriate additives. Mixing system shall be able to molecularly shear individual bentonite particles from the dry powder to avoid clumping and ensure thorough mixing. The boring fluid reservoir tank shall be large enough to accommodate the necessary fluid amount. Mixing system shall continually agitate the boring fluid during operation.
 - 2. Boring Fluid – Drilling fluid shall be composed of clean water and an appropriate additive. Water shall be from a clean source with a pH of 8.5-10. Water of a lower pH or with excessive calcium shall be treated with the appropriate amount of sodium carbonate or equal. The water and additives shall be mixed thoroughly and be absent of any clumps or clods. No hazardous additives may be used. Boring fluid shall be maintained at a viscosity sufficient to suspend cuttings and main the integrity of bore wall.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

- A. Many raceways will remain empty, with conductors installed in another Contract. All raceways installed for future use shall have a 1/4-inch nylon pull-cord installed and secured at each end.
- B. Install raceways with not more than 270 degrees of bend, total, in each raceway run between boxes, manholes, handholes and raceway terminations.
- C. Unless otherwise noted, minimum raceway size shall be 1 inch for underground raceways.

- D. Cut raceway ends square, ream and extend maximum distance into all couplings and connectors. Tighten all fittings securely. Filed cut threads and reamed ends in metal conduit shall be protected from corrosion immediately after cutting, reaming and cleaning by application of a zinc rich coating.
- E. Metallic raceway joints shall be electrically continuous by use of conductive joint compounds, Thomas & Betts "Kopr-Shield" or approved equal.
- F. Install manufactured end caps or plugs on all raceway ends immediately after installation to prevent the entrance of liquids or foreign materials.
- G. Bends in GRSC shall be factory pre-fabricated 90 degree bends or field bent. Field bending shall be done using one-shot or segment benders which do not decrease the raceway cross-section. Bending shall be done in accordance with manufacturer's instructions.
- H. Minimum bend radius for raceways within structures shall be in accordance with Table 2, Chapter 9, in the NEC.
- I. Minimum bend radius for raceways installed underground shall be as shown in Table C, except where otherwise indicated.

TABLE C
UNDERGROUND CONDUIT MINIMUM BENDING RADIUS

Conduit Size (inches)	Conduit Radius (inches)
1.0	14
1.25	18
1.5	18
2.0	24
2.5	27
3.0	30
3.5	33
4.0	36
5.0	42
6.0	48

- J. Route raceways to avoid structural obstructions and to minimize crossovers. Should core drilling or installation of sleeves not shown on the Contract Drawings be desired by the Contractor, such proposed penetrations shall be submitted to the Engineer prior to any core drilling or sleeving.
- K. Install expansion fittings with grounding jumpers where raceways cross expansion joints, construction joints, sawn joints, and where shown.
- L. All connections shall be watertight, except for non-liquid tight flexible metal conduit.
- M. Install PVC conduit in accordance with manufacturer's instructions. Cut the conduit ends square, and apply an approved solvent to clean the joint. Apply approved cement and allow to set 24 hours before mandrelling, brushing and installing conductors.

- N. This paragraph covers bends in PVC conduit runs underground but not in ductbanks. See SECTION 26 05 43 – Systemwide Electrical Underground Ductbanks For Systems, for bends in PVC conduit runs in ductbanks. PVC/GRSC shall be used for conduit bends 30 degrees or greater in PVC conduit runs underground but not in ductbanks. Bends in PVC conduit runs underground but not in ductbanks that are less than 30 degrees shall be factory PVC prefabricated bends or field bent PVC conduit. Field bends in PVC conduit with a radius of 100 feet or less shall be formed hot using only a heater recommended by the conduit manufacturer. Use conduit plugs during bending for conduit 2 inches and larger. Remove plugs only after conduit has cooled. Field bends (sweeps) with radius greater than 100 feet may be formed cold.
- O. All PVC conduits entering manholes or handholes shall be terminated with bell-end fittings or Term-a-duct.
- P. PVC/GRSC and fittings require special installation methods, and shall be installed in strict accordance with the manufacturer's instructions. Provide PVC boot to cover all exposed threads. Touch-up minor slice, nick, or abrasion damage to PVC coating with patching compound approved by the conduit manufacturer. Slices more than 10 mils in depth, and nicks and abrasions more than 10 mils in depth or 1/4-inch in diameter are considered major damage. Patching compound shall not be used to correct major damage. Conduits and fittings with major damage shall be replaced. The Engineer shall be the sole judge of whether coating damage is minor or major.

3.2 COATING OF METALLIC CONDUIT

- A. Wherever GRSC or GRS conduits are shown on the Contract Drawings or otherwise specified, the conduits and fittings shall be PVC/GRSC (PGRS), unless specifically called out as being uncoated.

3.3 REQUIREMENTS FOR RACEWAY TYPES

- A. For concrete encased conduits in underground ductbanks, provide Schedule 40 PVC conduit and raceway.
- B. For direct buried underground conduit, not in ductbank, installed in trackway or under track crossing provide PVC/GRSC.
- C. For direct buried underground conduit, not in a ductbank and not installed in the trackway or under track crossing provide Schedule 40 PVC conduit.
- D. For conduits installed in Overhead Contact System (OCS) feeder pole foundations, provide PVC conduit and elbows.
- E. For conduits installed in signal pole foundations, provide Schedule 40 PVC conduit and elbows.
- F. For conduits installed through traction power substation foundation walls, provide term-a-duct watertight duct connection.

3.4 RACEWAYS INSTALLED UNDERGROUND

- A. Slope raceways entering manholes and handholds to drain towards them. Slope raceways to drain away from buildings.
- B. Install raceways a minimum of 24 inches below final grade unless otherwise indicated.

- C. Dewater all excavations and raceways.
- D. Install yellow warning tape 12 inches above direct buried raceways.
- E. Direct buried conduit shall be encased and embedded in 4 inches of clean sharp sand on all sides of the raceway.

3.5 SLEEVES

- A. All sleeves shall be PVC/GRSC or Schedule 40 PVC as noted in Contract Drawings.
- B. Install, in advance of pouring concrete, all sleeves where shown. Sleeves shall terminate flush with the surface of the concrete with a coupling.

3.6 RACEWAYS STUBBED UP THROUGH FLOORS, WALLS, FOOTINGS OR FOUNDATIONS

- A. Install at such depth that the exposed raceway is vertical and no curved section of the elbow is visible.
- B. PVC/GRSC shall be provided for all raceways installed through floors, walls, footings or foundations. PVC conduit shall not be stubbed through floors, walls, footings or foundations. PVC conduit may be terminated in vault walls as shown on the Contract Drawings.

3.7 CONDUIT MANDRELLING AND CLEANING

- A. A log shall be kept for all conduits mandrelled. The mandrel log shall contain the following information in tabular format for each conduit mandrelled:
 - 1. Conduit designation
 - 2. Conduit endpoints
 - 3. Conduit size
 - 4. Date mandrelled
 - 5. Pass/fail for specified mandrel
- B. After final assembly is in place, all conduit 2 inches and larger shall be thoroughly mandrelled and cleaned prior to installing wires or pull cords. Each conduit shall be mandrelled by pulling a mandrel sized in accordance with these Specifications through the conduits, followed by a steel bristle brush to clean the conduit.
- C. After final assembly is in place, all conduits smaller than 2 inches shall be thoroughly cleaned and mandrelled by one of the following methods:
 - 1. Pulling through the conduits a mandrel and wire brush sized 1/4 inch maximum less than the inside diameter of the conduit for 1-1/2 inch and 1-1/4 inch conduits, and 1/8 inch maximum less than the inside diameter of the conduit for 1-inch and smaller conduits.
 - 2. Pulling through the conduits a cloth rag or conductor bundle sized 1/4 inch maximum less than the inside diameter of the conduit for 1-1/2 inch and 1-1/4 inch conduits, and 1/8 inch maximum less than the inside diameter of the conduit for 1-inch and smaller conduits.
- D. At the completion of mandrelling and cleaning, and before Final Acceptance, a 1/8 inch nylon pull cord shall be installed in each empty conduit. The pull cord shall remain accessible from each end at all times.

- E. If requested by the Engineer, mandrelling and cleaning shall be done in the presence of the Engineer. Notify the Engineer 7 days in advance of mandrelling.
- F. Where raceways are stubbed and capped, the pull cord shall extend through a drilled hole in the cap.
- G. Raceways which cannot meet the requirements for mandrelling shall be deemed defective, and shall be replaced as directed by the Engineer.

3.8 INSTALLATION AND OPERATION OF DIRECTIONAL BORING

- A. All personnel shall be fully trained in their respective duties as part of the directional boring crew and in safety. Training shall be provided specific to the project if any potential hazards may be encountered which has not already been included in personnel's training.
- B. Prior to any alterations to the work-site, the Contractor shall photograph the work area, including entry and exit points. Work site as indicated on the Contract Drawings, within right-of-way, shall be graded or filled to provide a level working area. No alterations beyond what is required for operations are to be made. The Contractor shall confine all activities to designated work areas.
- C. Entire drill path shall be accurately surveyed with entry and exit stakes placed in the appropriate locations within the areas indicated on the Contract Drawings. If the Contractor is using a magnetic guidance system, drill path will be surveyed for any surface geomagnetic variations or anomalies.
- D. The Contractor shall place silt fence between all boring operations and any drainage, wetland, waterway or other area designated for such protection by the Contract Documents, State, Federal and Local regulations. Additional environmental protection necessary to contain any hydraulic or boring fluid spills shall be put in place, including berms, liners, turbidity curtains and other measures. The Contractor shall adhere to all applicable environmental regulations. Fuel or oil may not be stored in bulk containers within 200 feet of any water-body or wetland.
- E. The Contractor shall notify all companies with underground utilities in the work area to obtain utility locates. Once the utilities have been located, the Contractor shall physically identify the exact location of the utilities by vacuum or hand excavation, when possible, in order to determine the actual location and path of any underground utilities which might be within 20 feet of the bore path. The Contractor shall not commence boring operations until the location of all underground utilities within the work area have been verified.
- F. Pipe shall be connected together in one length prior to pull-back operations, if space permits. Steel pipe welds will be x-rayed prior to being placed in bore hole. Pipe will be placed on pipe rollers before pulling into bore hole with rollers spaced close enough to prevent excessive sagging of pipe.
- G. Upon successful completion of pilot hole, the Contractor will ream bore hole to a minimum of 25% greater than outside diameter of pipe using the appropriate tools. The Contractor will not attempt to ream at one time more than the boring equipment and mud system are designed to safely handle.
- H. After reaming bore hole to the required diameter, the Contractor will pull the pipe through the bore hole. In front of the pipe will be a swivel. Once pull-back operations have commenced, operations must continue without interruption until pipe is completely pulled into bore hole. During pull-back operations the Contractor will not apply more than the maximum safe pipe pull pressure at any time. In the event that pipe becomes stuck, the Contractor will cease pulling operations to allow any potential hydro-lock to subside and will commence pulling operations.

- I. Following boring operations, the Contractor will de-mobilize equipment and restore the work-site to original condition. All excavations will be backfilled and compacted to 95% of original density. Landscaping will be restored to original.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

- A. The quantities of accepted work will be measured in the following units. All measurements will be plan measure except for authorized changes.
 1. Description: Lump Sum

4.2 PAYMENT

- A. Payment will be made at the respective unit or lump-sum price listed in the proposal and shall be full compensation for all labor, materials, and equipment necessary to complete the respective unit in place. There will be no separate measurement or payment for any item of work not specifically identified and listed in the proposal, and all such work shall be considered a subsidiary item with all costs pertaining thereto included in the prices for other items listed in the proposal. At the Engineer's option, partial payment may be made for any lump sum item listed in the proposal, providing that the Contractor is diligently and satisfactorily pursuing full completion of such partially complete item in accordance with the approved job progress schedule.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 26 05 33**RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS**

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Metal conduits, tubing, and fittings.
2. Nonmetal conduits, tubing, and fittings.
3. Metal wireways and auxiliary gutters.
4. Nonmetal wireways and auxiliary gutters.
5. Surface raceways.
6. Boxes, enclosures, and cabinets.
7. Handholes and boxes for exterior underground cabling.

B. Related Requirements:

1. Division 26 Section "Underground Ducts and Raceways for Electrical Systems" for exterior ductbanks, manholes, and underground utility construction.
2. Division 27 Section "Pathways for Communications Systems" for conduits, wireways, surface pathways, innerduct, boxes, faceplate adapters, enclosures, cabinets, and handholes serving communications systems.

1.02 ACTION SUBMITTALS

A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

B. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

C. LEED Submittals:

1. Product Data for Credit IEQ 4.1: For solvent cements and adhesive primers, documentation including printed statement of VOC content.
2. Laboratory Test Reports for IEQ 4: For solvent contents and adhesive primers, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

1.03 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:
 - 1. Structural members in paths of conduit groups with common supports.
 - 2. HVAC and plumbing items and Design Professional features in paths of conduit groups with common supports.

PART 2 - PRODUCTS

2.01 METAL CONDUITS, TUBING, AND FITTINGS

- A. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. GRC: Comply with ANSI C80.1 and UL 6.
- C. IMC: Comply with ANSI C80.6 and UL 1242.
- D. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.
 - 1. Comply with NEMA RN 1.
 - 2. Coating Thickness: 0.040 inch, minimum.
- E. EMT: Comply with ANSI C80.3 and UL 797.
- F. FMC: Comply with UL 1; zinc-coated steel.
- G. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.
- H. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
 - 1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886 and NFPA 70.
 - 2. Fittings for GRC, IMC, EMT:
 - a. Material: Steel.
 - b. Type: Compression. Set screw type fittings shall not be allowed.
 - 3. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.
 - 4. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch, with overlapping sleeves protecting threaded joints.
- I. Joint Compound for IMC, or GRC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.02 NONMETALLIC CONDUITS, TUBING, AND FITTINGS

- A. Listing and Labeling: Nonmetallic conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
- C. LFNC: Comply with UL 1660.
- D. Continuous HDPE: Comply with UL 651B.
- E. Coilable HDPE: Preassembled with conductors or cables, and complying with ASTM D 3485.
- F. Fittings for RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.
- G. Fittings for LFNC: Comply with UL 514B.
- H. Solvent cements and adhesive primers shall have a VOC content of 510 and 550 g/L or less, respectively, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.03 METAL WIREWAYS AND AUXILIARY GUTTERS

- A. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1 or Type 3R unless otherwise indicated, and sized according to NFPA 70.
 - 1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

2.04 SURFACE RACEWAYS

- A. Listing and Labeling: Surface raceways poles shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Surface Metal Raceways: Galvanized steel with snap-on covers complying with UL 5.
- C. Surface Nonmetallic Raceways: Two- or three-piece construction, complying with UL 5A, and manufactured of rigid PVC. Product shall comply with UL 94 V-0 requirements for self-extinguishing characteristics.

2.05 BOXES, ENCLOSURES, AND CABINETS

- A. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.
- B. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
- C. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.
- D. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.
- E. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing a 50 lb. Outlet boxes designed for attachment of luminaires weighing more than 50 lb shall be listed and marked for the maximum allowable weight.
- F. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- G. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, galvanized, cast iron with gasketed cover.
- H. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
- I. Device Box Dimensions: 4 inches square by 2-1/8 inches deep.
- J. Gangable boxes are allowed.
- K. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 or Type 3R with continuous-hinge cover with flush latch unless otherwise indicated.
 - 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
 - 2. Nonmetallic Enclosures: Plastic.
 - 3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.
- L. Cabinets:
 - 1. NEMA 250, Type 1 or Type 3R galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
 - 2. Hinged door in front cover with flush latch and concealed hinge.
 - 3. Key latch to match panelboards.
 - 4. Metal barriers to separate wiring of different systems and voltage.
 - 5. Accessory feet where required for freestanding equipment.
 - 6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.06 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

- A. General Requirements for Handholes and Boxes:

1. Boxes and handholes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.
 2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel, fiberglass, or a combination of the two.
1. Standard: Comply with SCTE 77.
 2. Configuration: Designed for flush burial with open bottom unless otherwise indicated.
 3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
 4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 5. Cover Legend: Molded lettering, "ELECTRIC" or as required.
 6. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.

PART 3 - EXECUTION

3.01 RACEWAY APPLICATION

- A. Outdoors: Apply raceway products as specified below unless otherwise indicated:
1. Exposed Conduit: GRC.
 2. Concealed Conduit, Aboveground: EMT.
 3. Underground Conduit: RNC, Type EPC-40-PVC.
 4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
 5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.
- B. Indoors: Apply raceway products as specified below unless otherwise indicated.
1. Exposed, Not Subject to Physical Damage: EMT.
 2. Exposed and Subject to Severe Physical Damage: GRC.
 3. Concealed in Ceilings and Interior Walls and Partitions: EMT.
 4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
 5. Damp or Wet Locations: GRC.
 6. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel in institutional and commercial kitchens and damp or wet locations.
- C. Minimum Raceway Size: 3/4-inch trade size.
- D. Raceway Fittings: Compatible with raceways and suitable for use and location.
1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.

2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
 3. EMT: Use compression, steel fittings. Comply with NEMA FB 2.10.
 4. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.
- E. Aluminum conduits shall not be allowed.
- F. Install surface raceways only when recessed is not possible.
- G. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F.

3.02 INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.
- B. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- C. Comply with requirements in Division 26 Section "Hangers and Supports for Electrical Systems" for hangers and supports.
- D. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- E. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches of changes in direction.
- F. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- G. Support conduit within 12 inches of enclosures to which attached.
- H. Stub-ups to Above Recessed Ceilings:
1. Use EMT, IMC, or RMC for raceways.
 2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
- I. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.
- J. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.

- K. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.
- L. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch trade size and insulated throat metal bushings on 1-1/2-inch trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.
- M. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.
- N. Surface Raceways:
 - 1. Install surface raceway with a minimum 2-inch radius control at bend points.
 - 2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.
- O. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces.

PART 4 - See Evaluations for discussion of types of and locations for raceway seals.

- A. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:
 - 1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 - 2. Where an underground service raceway enters a building or structure.
 - 3. Where otherwise required by NFPA 70.
- B. Expansion-Joint Fittings:
 - 1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F and that has straight-run length that exceeds 25 feet.
 - 2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
 - a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
 - b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
 - c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.
 - d. Attics: 135 deg F temperature change.

3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per degree F of temperature change for PVC conduits.
 4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
 5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.
- C. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches of flexible conduit for recessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
1. Use LFMC in damp or wet locations subject to severe physical damage.
 2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.
- D. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.
- E. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between the box and cover plate or the supported equipment and box.
- F. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.
- G. Locate boxes so that cover or plate will not span different building finishes.
- H. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.
- I. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

4.02 INSTALLATION OF UNDERGROUND CONDUIT

- A. Underground Conduit:
1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Division 31 Section "Earth Moving" for pipe less than 6 inches in nominal diameter.
 2. Install backfill as specified in Division 31 Section "Earth Moving."
 3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final

conduit connection at end of run and complete backfilling with normal compaction as specified in Division 31 Section "Earth Moving."

4. Install manufactured duct elbows for stub-up at poles and equipment and at building entrances through floor unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.
5. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.
 - a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete for a minimum of 12 inches on each side of the coupling.
 - b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.
6. Underground Warning Tape: Comply with requirements in Division 26 Section "Identification for Electrical Systems."

4.03 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.
- B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.
- C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch above finished grade.
- D. Install handholes with bottom below frost line, below grade.
- E. Field-cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

4.04 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Division 26 Section "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

4.05 PROTECTION

- A. Protect coatings, finishes, and cabinets from damage and deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 26 05 33

SECTION 26 05 43**UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS****PART 1 - GENERAL****1.01 SUMMARY**

- A. This Section includes the following:
 - 1. Conduit, ducts, and duct accessories for direct-buried and concrete-encased duct banks.
 - 2. Handholes and boxes.

1.02 ACTION SUBMITTALS

- A. Product Data: For accessories for manholes, handholes, and boxes.
- B. Shop Drawings for Factory-Fabricated Handholes and Boxes: Include dimensioned plans, sections, and elevations, and fabrication and installation details, including the following:
 - 1. Duct entry provisions, including locations and duct sizes.
 - 2. Cover design.
 - 3. Grounding details.
 - 4. Dimensioned locations of cable rack inserts, and pulling-in and lifting irons.

1.03 INFORMATIONAL SUBMITTALS

- A. Field quality-control test reports.

1.04 QUALITY ASSURANCE

- A. Comply with ANSI C2.
- B. Comply with NFPA 70.

PART 2 - PRODUCTS**2.01 CONDUIT**

- A. RNC: NEMA TC 2, Type EPC-40-PVC, UL 651, with matching fittings by same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B.

2.02 NONMETALLIC DUCTS AND DUCT ACCESSORIES

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. ARNCO Corp.
 2. Beck Manufacturing.
 3. Cantex, Inc.
 4. CertainTeed Corp.; Pipe & Plastics Group.
 5. Condux International, Inc.
 6. ElecSys, Inc.
 7. Electri-Flex Company.
 8. IPEX Inc.
 9. Lamson & Sessions; Carlon Electrical Products.
 10. Manhattan/CDT; a division of Cable Design Technologies.
 11. Spiraduct/AFC Cable Systems, Inc.
- B. Underground Plastic Utilities Duct: NEMA TC 6 & 8, Type EB-20-PVC, ASTM F 512, UL 651A, with matching fittings by the same manufacturer as the duct, complying with NEMA TC 9.
- C. Duct Accessories:
1. Duct Separators: Factory-fabricated rigid PVC interlocking spacers, sized for type and sizes of ducts with which used, and selected to provide minimum duct spacings indicated while supporting ducts during concreting or backfilling.
 2. Warning Tape: Underground-line warning tape specified in Division 26 Section "Identification for Electrical Systems."
 3. Concrete Warning Planks: Nominal 12 by 24 by 3 inches in size, manufactured from 6000-psi concrete.
 - a. Color: Red dye added to concrete during batching.
 - b. Mark each plank with "ELECTRIC" in 2-inch- high, 3/8-inch- deep letters.

2.03 HANDHOLES AND BOXES

- A. Description: Comply with SCTE 77.
1. Color: Gray.
 2. Configuration: Units shall be designed for flush burial and have open bottom, unless otherwise indicated.
 3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
 4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 5. Cover Legend: Molded lettering, "ELECTRIC." Or "TELEPHONE."
 6. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
 7. Handholes 12 inches wide by 24 inches long and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

- B. Fiberglass Handholes and Boxes with Polymer Concrete Frame and Cover: Sheet-molded, fiberglass-reinforced, polyester resin enclosure joined to polymer concrete top ring or frame.
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Armorcast Products Company.
 - b. Carson Industries LLC.
 - c. Christy Concrete Products.
 - d. Synertech Moulded Products, Inc.; a division of Oldcastle Precast.

PART 3 - EXECUTION

3.01 EARTHWORK

- A. Excavation and Backfill: Comply with Division 31 Section "Earth Moving," but do not use heavy-duty, hydraulic-operated, compaction equipment.
- B. Restore surface features at areas disturbed by excavation and reestablish original grades, unless otherwise indicated. Replace removed sod immediately after backfilling is completed.
- C. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Division 32 Sections "Turf and Grasses" and "Plants."
- D. Cut and patch existing pavement in the path of underground ducts and utility structures according to Division 01 Section "Cutting and Patching."

3.02 DUCT INSTALLATION

- A. Slope: Pitch ducts a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope ducts from a high point in runs between two manholes to drain in both directions.
- B. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 48 inches, both horizontally and vertically, at other locations, unless otherwise indicated.
- C. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in same plane.
- D. Duct Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 10 inches o.c. for 5-inch ducts, and vary proportionately for other duct sizes.

1. Begin change from regular spacing to end-bell spacing 10 feet from the end bell without reducing duct line slope and without forming a trap in the line.
 2. Direct-Buried Duct Banks: Install an expansion and deflection fitting in each conduit in the area of disturbed earth adjacent to manhole or handhole.
 3. Grout end bells into structure walls from both sides to provide watertight entrances.
- E. Building Wall Penetrations: Make a transition from underground duct to rigid steel conduit at least 10 feet outside the building wall without reducing duct line slope away from the building, and without forming a trap in the line. Use fittings manufactured for duct-to-conduit transition. Install conduit penetrations of building walls as specified in Division 26 Section "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."
- F. Sealing: Provide temporary closure at terminations of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig hydrostatic pressure.
- G. Pulling Cord: Install 100-lbf- test nylon cord in ducts, including spares.
- 3.03 INSTALLATION OF HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE
- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of ducts, and seal joint between box and extension as recommended by the manufacturer.
- B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.
- C. Elevation: In paved areas and trafficways, set so cover surface will be flush with finished grade. Set covers of other handholes 1 inch above finished grade.
- D. Install handholes and boxes with bottom below the frost line, below grade.
- E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in the enclosure.
- F. Field-cut openings for ducts and conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3.04 GROUNDING

- A. Ground underground ducts and utility structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."

3.05 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 - 1. Demonstrate capability and compliance with requirements on completion of installation of underground ducts and utility structures.
 - 2. Pull aluminum or wood test mandrel through duct to prove joint integrity and test for out-of-round duct. Provide mandrel equal to 80 percent fill of duct. If obstructions are indicated, remove obstructions and retest.
 - 3. Test handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Division 26 Section "Grounding and Bonding for Electrical Systems."
- B. Correct deficiencies and retest as specified above to demonstrate compliance.

3.06 CLEANING

- A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.
- B. Clean internal surfaces of manholes, including sump. Remove foreign material.

END OF SECTION 26 05 43

SECTION 26 05 43**SYSTEMWIDE ELECTRICAL UNDERGROUND DUCTBANKS AND RACEWAYS FOR SYSTEMS****PART 1 - GENERAL****1.1 SUMMARY**

- A. This Work includes providing ductbanks as shown on the Contract Drawings and as specified herein. Ductbanks shall be defined as one or more raceways and fitting combinations embedded in steel reinforced concrete, non-steel reinforced concrete, Controlled Density Fill (CDF) concrete, or sand.
- B. Raceways emerging from ductbanks and direct-buried shall comply with the requirements of SECTION 26 05 00 – Systemwide Electrical General Requirements for Systems and SECTION 26 05 33 – Systemwide Electrical Raceways for Systems.

1.2 RELATED SECTIONS

- A. SECTION 01 43 00 – Systems Quality Assurance
- B. SECTION 03 20 00 – Concrete Reinforcing
- C. SECTION 26 05 00.13 – Systemwide Electrical General Requirements for Systems
- D. SECTION 26 05 33.13 – Systemwide Electrical Raceways for Systems
- E. SECTION 31 23 33 – Utility Trenching and Backfilling

1.3 REFERENCES AND STANDARDS

- A. Institute of Electrical and Electronic Engineers (IEEE)
 - 1. IEEE C2 National Electrical Safety Code (NESC)
- B. National Fire Protection Association (NFPA)
 - 1. NFPA 70 National Electrical Code (NEC)

1.4 QUALITY ASSURANCE/QUALITY CONTROL

- A. Quality Assurance/Quality Control shall be carried out in accordance with the requirements of SECTION 01 43 00 Systems Quality Assurance.
- B. As-built drawings shall be provided in accordance with the requirements of SECTION 26 05 00.13 – Systemwide Electrical General Requirements for Systems, except as modified herein.
- C. As-built drawings shall show the location of all underground ductbanks and the number and size of conduits therein.
- D. Comply with ANSI/IEEE C2.
- E. Comply with NFPA 70.

1.5 SUBMITTALS

- A. Submittals shall be made in accordance with the requirements of SECTION 26 05 00.13 – Systemwide Electrical General Requirements for Systems, except as modified herein.
- B. Mandrel Log

PART 2 - PRODUCTS**2.1 RACEWAYS**

- A. Raceways, fittings and labels shall comply with SECTION 26 05 33.13 – Systemwide Electrical Raceways for Systems.
- B. Raceway spacers shall be plastic, lock together, and be sized to create clear spaces of 3 inches or greater between Traction Electrification (TE) or Medium-Voltage raceways and 1-1/2 inches or greater between all other raceways between raceways as indicated. Approved manufacturers are Carlon, PW Pipe, or approved equal.

2.2 WARNING TAPE

- A. Tape shall be heavy-gauge, yellow, plastic for direct burial, 6-inch minimum width for use in trenches containing electric circuits. Tape shall be made of material resistant to corrosive soil. Tape shall have printed warning that an electric circuit is located below the tape. Approved manufacturers and types are ITT Blackburn Type YT, Griffolyn Co., Terra-Tape, or approved equal.

2.3 ENCASEMENT AND REINFORCEMENT

- A. Concrete encasement and steel reinforcement for lateral ductbank runs shall be in accordance with SECTION 03 20 00 – Concrete Reinforcing.
 - 1. Mainline ductbank runs shall be CDF concrete, or sand.
 - 2. Signals/Communications (SC) lateral runs shall be 1500 psi concrete.
 - 3. Traction Electrification (TE) lateral runs from Substation foundations and DC switches to trackway shall be red 3000 psi concrete and No. 4 steel reinforced.
 - 4. TE lateral runs in trackway shall be red 3000 psi concrete with no steel reinforcement.
 - 5. TE lateral runs from manhole to Overhead Contact System (OCS) pole foundation in trackway shall be red 3000 psi concrete with no steel reinforcement.

2.4 RED CONCRETE

- A. Red concrete shall be made by mixing-in Tilered dye in a ratio of 3 pounds per sack of cement.
- B. Red concrete shall be used to encase all medium, high voltage and TE ductbanks.
- C. Red concrete shall be 3000 psi with 4 inch slump.

PART 3 - EXECUTION**3.1 GENERAL**

- A. Where required to support trench, construct formwork in accordance with SECTION 31 23 33 – Utility Trenching And Backfilling.
- B. Coordinate installation of underground raceways with other construction Work. Maintain any existing utilities in operation unless otherwise directed by the Engineer.
- C. Concrete encasement shall be limited to the neat lines shown on the Contract Documents. The Contractor shall be responsible for coordinating placement of the concrete with other Work. If the ductbank conflicts with other Work it shall be relocated by Contractor at no additional cost to KCMO.
- D. Protect and maintain all new or existing benchmarks or other reference points necessary for the completion of the Work.
- E. Where galvanized rigid steel conduit (GRSC) and fittings are used encased in concrete, use polyvinyl chloride (PVC) coated GRSC in accordance with SECTION 26 05 33.13 – Systemwide Electrical Raceways for Systems.
- F. Many ducts will be empty and conductors will be installed in the future. All ducts installed for future use shall have a nylon pull-cord installed and secured at each end.
- G. All ductbanks shall have a trace wire installed along its entire length initiating from a manhole and terminating at the ductbanks end. Trace wires installed within a manhole shall be terminated within an appropriately rated enclosure on a terminal strip and identified with its corresponding ductbank number. Tie-in trace wires to the existing conduits installed in prior contracts.

3.2 TRENCH EXCAVATION AND BACKFILL

- A. Follow the requirements SECTION 31 23 33 – Utility Trenching And Backfilling, except blasting will not be permitted. Provide a minimum cover of 24 inches over all underground ductbanks unless otherwise indicated. Measurement shall be taken from finished grade of track slab to top of ductbank encasement. Leave minimum 3 inches between track slab bottom and top of ductbank encasement.
- B. When trench walls are stable, use the walls of the trench as forms for concrete encasement. The trench shall be made no wider than necessary to provide the nominal concrete encased ductbank.
- C. Excavations shall be dewatered and the excavation cleaned prior to raceway and concrete placement.
- D. Provide a compacted base under the ductbank.
- E. Install yellow warning tape 3 inches above ductbank encasement.

3.3 REQUIREMENTS FOR RACEWAY TYPES

- A. Galvanized rigid steel conduit (GRSC) or PVC/GRSC shall be used for pre-fabricated 90 degree bends in PVC conduit runs where the bend radius is less than 6 feet. Minimum permissible bend radius is 36 inches.

- B. Schedule 40 PVC conduit may be used for bends in PVC ductbanks if the bend radius is greater than 6 feet (90 degrees of bend in 9.5 feet of conduit length). Bends in PVC conduit shall be factory pre-fabricated bends or field bent. Field bends in PVC conduit with less than a 100-foot radius shall be formed hot using only a heater recommended by the conduit manufacturer. Use conduit plugs during bending for conduit 2 inches and larger. Remove plugs only after conduit has cooled. Field bends with a radius greater than 100 feet may be formed cold. When placing cold bends, maintain adequate spacing from the inside of the bend to excavation walls for the required 3 inches of concrete.

3.4 RACEWAY PLACEMENT

- A. Raceways shall be arranged as shown on the Contract Drawings.
- B. Generally the ductbank is located below the track slab at a minimum depth of 24 inches below finished grade. Leave minimum 3 inches between track slab bottom and top of ductbank encasement. Lateral ductbank crossing below the track is permitted as long as the ductbank meets the minimum depth requirements. Where obstacles are encountered the ductbank shall gradually offset around them and must meet the concrete-encasement and conduit bending requirements.
- C. Traction Electrification ductbank is located below the track slab at a minimum depth of 24 inches below finished grade. Traction Electrification ductbank located outside of the track slab shall be installed at a minimum depth of 24 inches below finished grade.
- D. Ductbanks for utility systems shall maintain a minimum 5 foot horizontal separation unless otherwise indicated on the Contract Drawings or Approved by the Engineer.
- E. Slope all raceway for drainage to manholes or handholes away from buildings.
- F. Raceway spacers shall be placed at maximum 5-foot intervals. Bending radii indicated on the Contract Drawings and specified herein are to be considered minimum, unless noted otherwise.
- G. Terminate all PVC conduit ductbank entering the manholes from the sidewall with approved bell ends glued to the ends of the PVC conduits or term-a-duct.
- H. Secure raceways to prevent displacement during concrete encasement or earth backfilling. Make minor changes in location or cross-section as necessary to avoid obstructions or conflicts. Where raceway runs cannot be installed as shown because of conditions not discoverable prior to trenching, refer the condition to the Engineer for direction before further work is done.
- I. When placing concrete around the raceways, adjust the delivery chute so the fall distance of the concrete into the trench is minimal. Concrete direct fall distance shall be 2 feet or less. Use a splash board to divert the flow of concrete away from the trench sides and avoid dislodging soil and stones.
- J. As concrete is poured, mechanically vibrate the concrete continuously to eliminate voids and consolidate it around the reinforcing steel and conduits. Do not over vibrate.
- K. All plastic raceways may expand or contract as concrete is placed and cured. Therefore, when placing concrete encasement, always encase from one end of the duct section toward the other end to allow the free end to move. Never encase from each end of the section toward the center.
- L. Place concrete continuously between manholes, handholes and pullboxes. If the placement stops for more than 2 hours, 8 foot lengths of No. 4 reinforcement steel shall be placed longitudinally around the perimeter of the concrete envelope on 12 inch centers and with 2 inches minimum cover. Half of each 8-foot length shall be in each pour.

- M. Mandrel raceways and provide seals in accordance with SECTION 26 05 33.13 – Systemwide Electrical Raceways For Systems. Ductbank conduits shall be mandrelled after concrete encasement but before backfilling.

3.5 INSPECTION

- A. Ductbanks shall be inspected by the Engineer before placing concrete encasement. Notify the Engineer before placing concrete. Clean trenches, dewater and adjust clearances as directed to obtain the minimum concrete dimensions shown on the Contract Drawings.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

- A. The quantities of accepted work will be measured in the following units. All measurements will be plan measure except for authorized changes.
1. Description: Lump Sum

4.2 PAYMENT

- A. Payment will be made at the respective unit or lump-sum price listed in the proposal and shall be full compensation for all labor, materials, and equipment necessary to complete the respective unit in place. There will be no separate measurement or payment for any item of work not specifically identified and listed in the proposal, and all such work shall be considered a subsidiary item with all costs pertaining thereto included in the prices for other items listed in the proposal. At the Engineer's option, partial payment may be made for any lump sum item listed in the proposal, providing that the Contractor is diligently and satisfactorily pursuing full completion of such partially complete item in accordance with the approved job progress schedule.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 26 05 44**SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING****PART 1 - GENERAL****1.01 SUMMARY****A. Section Includes:**

1. Sleeves for raceway and cable penetration of non-fire-rated construction walls and floors.
2. Sleeve-seal systems.
3. Sleeve-seal fittings.
4. Grout.
5. Silicone sealants.

B. Related Requirements:

1. Section 07 84 13 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

1.02 ACTION SUBMITTALS**A. Product Data:** For each type of product.**B. LEED Submittals:**

1. Product Data for Credit EQ 4.1: For sealants, documentation including printed statement of VOC content.
2. Laboratory Test Reports for Credit EQ 4: For sealants, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

PART 2 - PRODUCTS**2.01 SLEEVES****A. Wall Sleeves:**

1. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

- B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.
- C. Sleeves for Rectangular Openings:
 - 1. Material: Galvanized sheet steel.
 - 2. Minimum Metal Thickness:
 - a. For sleeve cross-section rectangle perimeter less than 50 inches and with no side larger than 16 inches, thickness shall be 0.052 inch.
 - b. For sleeve cross-section rectangle perimeter 50 inches or more and one or more sides larger than 16 inches, thickness shall be 0.138 inch.

2.02 SLEEVE-SEAL SYSTEMS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Advance Products & Systems, Inc.
 - b. CALPICO, Inc.
 - c. Metraflex Company (The).
 - d. Pipeline Seal and Insulator, Inc.
 - e. Proco Products, Inc.
 - 2. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 - 3. Pressure Plates: Carbon steel.
 - 4. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

2.03 SLEEVE-SEAL FITTINGS

- A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Presealed Systems.

2.04 GROUT

- A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.

- B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

2.05 SILICONE SEALANTS

- A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.
 - 1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.
 - 2. Sealant shall have VOC content less than when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 3. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

PART 3 - EXECUTION

3.01 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

- A. Comply with NECA 1.
- B. Comply with NEMA VE 2 for cable tray and cable penetrations.
- C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:
 - 1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
 - a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants."
 - b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.
 - 2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
 - 3. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed.

4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
 5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches above finished floor level. Install sleeves during erection of floors.
- D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:
1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
 2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.
- E. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.
- F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using cast-iron pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- G. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing sleeve-seal system.

3.02 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.
- B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.03 SLEEVE-SEAL-FITTING INSTALLATION

- A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
- C. Secure nailing flanges to concrete forms.
- D. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION 26 05 44

SECTION 26 05 44**SYSTEMWIDE ELECTRICAL MANHOLES AND HANDHOLES FOR SYSTEMS****PART 1 - GENERAL****1.1 SUMMARY**

- A. This Work includes providing manholes and handholes as shown and as specified.
- B. Also included are excavation and backfill, accessories including covers, raceway termination and fittings, grounding, cable supports, cable pulling provisions, raceway labeling and drainage.

1.2 RELATED SECTIONS

- A. SECTION 26 05 00.13 – Systemwide Electrical General Requirements for Systems
- B. SECTION 26 05 26.13 – Systemwide Electrical Grounding for Systems
- C. SECTION 01 43 00 – Systems Quality Assurance

1.3 REFERENCES AND STANDARDS

- A. American Association of State Highway and Transportation Officials (AASHTO)
 - 1. AASHTO M 105 Manhole Frames and Covers
- B. American National Standards Institute/Society of Cable Telecommunications Engineers (ANSI/SCTE)
 - 1. ANSI/SCTE 77-2002 Specification for Underground Enclosure Integrity

1.4 QUALITY ASSURANCE

- A. Quality Assurance/Quality Control shall be in accordance with the requirements of SECTION 01 43 00 – Systems Quality Assurance, except as modified herein.

1.5 SUBMITTALS

- A. Submittals shall be made in accordance with the requirements of SECTION 26 05 00.13 – Systemwide Electrical General Requirements For Systems, except as modified herein.
- B. Items required to be submitted by the Contractor for Approval include, but are not limited to, the following:
 - 1. Product data for cable supports (racks)
 - 2. Product data for cable insulators
 - 3. Product data for pulling iron
 - 4. Product data for concrete damp proofing compound
 - 5. Shop drawings for manholes (each type) including cover and frame, cable supports and inserts, and any required extension sections.
 - 6. Shop drawings for handholes and manholes, including cover and frame, and any required extension sections.

PART 2 - PRODUCTS**2.1 PRECAST CONCRETE MANHOLES**

- A. Manholes shall be precast with 28-day, 4,500 psi or greater compressive strength concrete and designed for AASHTO H-20/HS-20 loading. Minimum dimensions for manholes are shown on the Contract Drawings. Extension sections shall be used to increase vertical dimensions to those shown on the Contract Drawings.
- B. Manholes shall provide raceway entrances on all four sides. Knockout panels or precast individual raceway openings may be used. On sides where no raceways are installed, provide knockout panels for future raceway installation. Provide knockout(s) or sleeves for ground rods.
- C. Manhole covers shall be identified by inscription according to the Contract Drawings.
- D. In manholes, provide heavy duty non-metallic cable racks with adjustable arms. Cable racks shall be compatible for use with the specific manhole submitted. Inserts for installation of cable racks shall be installed as an integral part of the manhole by the manufacturer and attachment hardware shall be 316 Stainless Steel. Do not use bolts or studs embedded in concrete for attaching racks. Unless otherwise specified, set racks and inserts on not greater than 3-foot centers around the entire inside perimeter of the manhole, arranged so that all raceway ends are clear for future cable installation. Manhole stanchions shall have two 4-inch arms each. Manhole racking shall comply with the clear working space requirements of ANSI C2 Rule 323B.
- E. For each manhole, provide one pulling iron embedded in the concrete wall near the floor opposite each raceway bank entering manholes in each corner unless otherwise indicated. Use 3/4-inch round stock securely fastened to the overall steel reinforcement before concrete is poured.
- F. Manhole hardware shall be hot-dip galvanized steel.
- G. Damp-proofing compound shall be factory applied, one coat, on all outside surfaces. Damp-proofing shall be coal-tar bitumastic.
- H. Approved manufacturers are Utility Vault Co., Concrete Pipe Inc., Old Castle Precast, or approved equal.

2.2 PRECAST POLYMER CONCRETE HANDHOLES

- A. Handholes shall be precast and meet a minimum ANSI/SCTE 77 rating of Tier 15 with a vertical design load of 15,000 pounds and a lateral design load of 22,500 pounds. All handholes will be open bottom with minimum dimensions shown on the Contract Drawings.
- B. Precast polymer concrete handholes shall not be used in areas subject to deliberate vehicular traffic which require an AASHTO H-20/HS-20 load rating.
- C. Potential installations using precast polymer concrete handholes shall require prior Approval by KCMO regarding location, type, size and load rating.
- D. Handhole covers shall be identified by inscription according to the Contract Drawings. The appropriate identification (electric, signal, communication) shall be cast into the exterior surface.
- E. All handhole hardware shall be of steel, hot-dip galvanized or stainless steel after fabrication.
- F. Precast polymer concrete handholes shall be installed according to manufacturer's instructions.

- G. Approved manufacturers are Quazite, or approved equal.
- H. Locking mechanism shall use stainless steel hex head bolts.

PART 3 - EXECUTION

3.1 INSTALLATION OF PRECAST CONCRETE MANHOLES AND POLYMER HANDHOLES

- A. General
 - 1. Location of manholes/handholes are shown in Contract Drawings
 - 2. Install longer side of the manhole/handhole parallel to tracks
- B. Excavation and Bedding
 - 1. The excavation shall be made to a depth to allow for the overall assembled height and bedding of manholes or handholes as shown on the Contract Drawings. Provide and install risers as shown to bring the manhole or handhole to the required finish grade.
 - 2. Over excavate at least 12 inches around the sidewalls of the manholes and handholes for ease of installation and to prevent sluffage.
 - 3. Bedding for manholes shall consist of 1-foot minimum depth of 3/4-inch minus crushed rock, graded level, and compacted.
- C. Inspection and Setting
 - 1. Excavation must be completely dewatered before setting manholes or handholes.
 - 2. Notify the Engineer 7 days in advance of the installation of each manhole or handhole.
 - 3. Assemble by lowering each section into the excavation.
 - 4. Lower the base section first, set level and firmly position before placing intermediate and top sections.
 - 5. Ensure that the seal surfaces between sections are clean and that the gaskets are in place.
 - 6. Completed manhole shall be inspected by the Engineer before backfilling.
- D. Backfilling
 - 1. Backfill around all manholes and handholes shall consist of approved compactable material such as 3/4-inch minus crushed rock, sand or clean earth fill containing no rocks larger than 3/4-inch. No voids shall remain between the manhole and handhole walls and native soil excavation.
- E. Grouting
 - 1. Grout risers, covers and raceway entering manholes and handholes with non-shrink cement grout consisting of 2 parts sand and 1 part cement and sufficient water to form heavy plastic slurry.
 - 2. Apply grout in a manner to ensure filling of all voids in the joint being sealed.

3.2 GROUNDING

- A. All manholes shall be grounded in accordance with SECTION 26 05 26.13 – Systemwide Electrical Grounding For Systems, and as shown on the Contract Drawings.
- B. All metallic components in each manhole, including covers and cover mounting frames, metallic raceway grounding bushings, cable racks and inserts shall be grounded. Provide a minimum of one driven ground rod. Connect the rod to all metallic parts using a copper bonding conductor. Grounding conductor shall be exothermically welded or connected with approved Burndy Irreversible Compression Fittings to the ground rod. Connection to other metallic parts may be by exothermic welding or bolting using stainless steel hardware.

3.3 IDENTIFICATION

- A. Identify each manhole and handhole with the numbers shown on the Contract Drawings and as required by this Specification.
- B. Identify each manhole with 3-inch high letters stenciled with black paint on white background or engraved on a placard with black letters on a white background. Identification shall be placed just below the cover on the inside wall. Placards shall be secured with stainless steel bolts. Paint shall be exterior latex masonry type.
- C. Handholes shall be identified with 2-inch high letters stenciled with black paint on white paint background on the underside of its cover. Paint shall be exterior latex masonry type.
- D. Identify each ductbank entering a manhole and each raceway within the ductbank as shown on the Contract Drawings. Numbers shall be 2-inches high stenciled with black paint on white paint background or engraved on a placard with black letters on a white background. Placards shall be secured with stainless steel bolts. Paint shall be exterior latex masonry type.
- E. Identify each raceway entering a handhole as shown on the Contract Drawings. Numbers shall be 1 inches high, stenciled with black paint on white paint background or engraved on a placard with black letters on a white background. Placards shall be secured with stainless steel bolts. Paint shall be exterior latex masonry type.

3.4 CABLE SUPPORTS

- A. Cable supports shall be installed by the Contractor.

PART 4 - MEASUREMENT AND PAYMENT**4.1 MEASUREMENT**

- A. The quantities of accepted work will be measured in the following units. All measurements will be plan measure except for authorized changes.
 - 1. Description: Lump Sum

4.2 PAYMENT

- A. Payment will be made at the respective unit or lump-sum price listed in the proposal and shall be full compensation for all labor, materials, and equipment necessary to complete the respective unit in place. There will be no separate measurement or payment for any item of work not specifically identified and listed in the proposal, and all such work shall be considered a subsidiary item with all costs pertaining thereto included in the prices for other items listed in the proposal. At the Engineer's option, partial payment may be made for any lump sum item listed in the proposal, providing that the Contractor is diligently and satisfactorily pursuing full completion of such partially complete item in accordance with the approved job progress schedule.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 26 05 53**IDENTIFICATION FOR ELECTRICAL SYSTEMS****PART 1 - GENERAL****1.01 SUMMARY**

- A. Section Includes:
1. Identification for raceways.
 2. Identification of power and control cables.
 3. Identification for conductors.
 4. Underground-line warning tape.
 5. Warning labels and signs.
 6. Instruction signs.
 7. Equipment identification labels.
 8. Miscellaneous identification products.

1.02 ACTION SUBMITTALS

- A. Product Data: For each electrical identification product indicated.

1.03 QUALITY ASSURANCE

- A. Comply with ANSI A13.1.
- B. Comply with NFPA 70.
- C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.
- D. Comply with ANSI Z535.4 for safety signs and labels.
- E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

PART 2 - PRODUCTS**2.01 POWER RACEWAY IDENTIFICATION MATERIALS**

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway size.
- B. Colors for Raceways Carrying Circuits at 600 V or Less:
1. Black letters on an orange field.

2. Legend: Indicate voltage.

- C. Self-Adhesive Vinyl Labels for Raceways Carrying Circuits at 600 V or Less: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

2.02 ARMORED AND METAL-CLAD CABLE IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.
- B. Colors for Raceways Carrying Circuits at 600 V and Less:
1. Black letters on an orange field.
 2. Legend: Indicate voltage.
- C. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

2.03 POWER AND CONTROL CABLE IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.
- B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

2.04 CONDUCTOR IDENTIFICATION MATERIALS

- A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.
- B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

2.05 FLOOR MARKING TAPE

- A. 2-inch- wide, 5-mil pressure-sensitive vinyl tape, with black and white stripes and clear vinyl overlay.

2.06 UNDERGROUND-LINE WARNING TAPE

- A. Tape:

1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
2. Printing on tape shall be permanent and shall not be damaged by burial operations.
3. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.

B. Color and Printing:

1. Comply with ANSI Z535.1 through ANSI Z535.5.
2. Inscriptions for Red-Colored Tapes: ELECTRIC LINE, HIGH VOLTAGE.
3. Inscriptions for Orange-Colored Tapes: TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE.

C. Tag: Type I:

1. Pigmented polyolefin, bright-colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
2. Thickness: 4 mils.
3. Weight: 18.5 lb/1000 sq. ft..
4. 3-Inch Tensile According to ASTM D 882: 30 lbf, and 2500 psi.

2.07 WARNING LABELS AND SIGNS

A. Comply with NFPA 70 and 29 CFR 1910.145.

B. Self-Adhesive Warning Labels: Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.

C. Metal-Backed, Butyrate Warning Signs:

1. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch galvanized-steel backing; and with colors, legend, and size required for application.
2. 1/4-inch grommets in corners for mounting.
3. Nominal size, 10 by 14 inches.

D. Warning label and sign shall include, but are not limited to, the following legends:

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."

2.08 INSTRUCTION SIGNS

A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch thick for signs up to 20 sq. inches and 1/8 inch thick for larger sizes.

1. Engraved legend with black letters on white face.
 2. Punched or drilled for mechanical fasteners.
 3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.
- B. Adhesive Film Label: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch.

2.09 EQUIPMENT IDENTIFICATION LABELS

- A. Screwed in with two screws minimum, Engraved, Laminated Acrylic or Melamine Label: Adhesive backed, with white letters on a dark-gray background. Minimum letter height shall be 3/8 inch.

2.10 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Paint: Comply with requirements in Division 09 painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).
- B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
- B. Apply identification devices to surfaces that require finish after completing finish work.
- C. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.
- D. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
- E. System Identification Color-Coding Bands for Raceways and Cables: Each color-coding band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.
- F. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.

- G. Painted Identification: Comply with requirements in Division 09 painting Sections for surface preparation and paint application.

3.02 IDENTIFICATION SCHEDULE

- A. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits More Than 30 A, and 120 V to ground: Install labels at 10-foot maximum intervals.
- B. Accessible Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage. System legends shall be as follows:
 - 1. Emergency Power.
 - 2. Normal Power.
 - 3. UPS.
- C. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.
 - 1. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded service conductors.
 - a. Color shall be factory applied.
 - b. Colors for 208/120-V Circuits:
 - 1) Phase A: Black.
 - 2) Phase B: Red.
 - 3) Phase C: Blue.
 - c. Colors for 480/277-V Circuits:
 - 1) Phase A: Brown.
 - 2) Phase B: Orange.
 - 3) Phase C: Yellow.
 - d. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.
- D. Install instructional sign including the color-code for grounded and ungrounded conductors using adhesive-film-type labels.
- E. Conductors to Be Extended in the Future: Attach write-on tags to conductors and list source.
- F. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.
 - 1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.

2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
 3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.
- G. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.
1. Limit use of underground-line warning tape to direct-buried cables.
 2. Install underground-line warning tape for both direct-buried cables and cables in raceway.
- H. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.
- I. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Metal-backed, butyrate warning signs.
1. Comply with 29 CFR 1910.145.
 2. Identify system voltage with black letters on an orange background.
 3. Apply to exterior of door, cover, or other access.
 4. For equipment with multiple power or control sources, apply to door or cover of equipment including, but not limited to, the following:
 - a. Power transfer switches.
 - b. Controls with external control power connections.
- J. Operating Instruction Signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.
- K. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.
1. Labeling Instructions:
 - a. Indoor Equipment: Engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch- high letters on 1-1/2-inch- high label; where two lines of text are required, use labels 2 inches high.
 - b. Outdoor Equipment: Engraved, laminated acrylic or melamine label.
 - c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
 - d. Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.

END OF SECTION 26 05 53

SECTION 26 05 73**OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY**

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes computer-based, fault-current and overcurrent protective device coordination studies. Protective devices shall be set based on results of the protective device coordination study.
 - 1. Coordination of series-rated devices is permitted where indicated on Drawings.

1.02 ACTION SUBMITTALS

- A. Product Data: For computer software program to be used for studies.
- B. Other Action Submittals: The following submittals shall be made after the approval process for system protective devices has been completed. Submittals shall be in digital form.
 - 1. Coordination-study input data, including completed computer program input data sheets.
 - 2. Study and Equipment Evaluation Reports.
 - 3. Coordination-Study Report.

1.03 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For coordination-study specialist.
- B. Product Certificates: For coordination-study and fault-current-study computer software programs, certifying compliance with IEEE 399.

1.04 QUALITY ASSURANCE

- A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are not acceptable.
- B. Coordination-Study Specialist Qualifications: An entity experienced in the application of computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.
 - 1. Professional Design Professional, licensed in the state where Project is located, shall be responsible for the study. All elements of the study shall be performed under the direct supervision and control of Design Professional.

- C. Comply with IEEE 242 for short-circuit currents and coordination time intervals.
- D. Comply with IEEE 399 for general study procedures.

PART 2 - PRODUCTS

2.01 COMPUTER SOFTWARE DEVELOPERS

- A. Available Computer Software Developers: Subject to compliance with requirements, companies offering computer software programs that may be used in the Work include, but are not limited to, the following:
 - 1. CGI CYME.
 - 2. EDSA Micro Corporation.
 - 3. ESA Inc.
 - 4. Operation Technology, Inc.
 - 5. SKM Systems Analysis, Inc.

2.02 COMPUTER SOFTWARE PROGRAM REQUIREMENTS

- A. Comply with IEEE 399.
- B. Analytical features of fault-current-study computer software program shall include "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.
- C. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer-generated, time-current coordination plots.

PART 3 - EXECUTION

3.01 POWER SYSTEM DATA

- A. Gather and tabulate the following input data to support coordination study:
 - 1. Product Data for overcurrent protective devices specified in other Division 26 Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
 - 2. Impedance of utility service entrance.
 - 3. Electrical Distribution System Diagram: In hard-copy and electronic-copy formats, showing the following:
 - a. Circuit-breaker and fuse-current ratings and types.
 - b. Relays and associated power and current transformer ratings and ratios.

- c. Transformer kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R ratios.
 - d. Cables: Indicate conduit material, sizes of conductors, conductor material, insulation, and length.
 - e. Busway ampacity and impedance.
 - f. Motor horsepower and code letter designation according to NEMA MG 1.
4. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram, showing the following:
- a. Special load considerations, including starting inrush currents and frequent starting and stopping.
 - b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.
 - c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
 - d. Ratings, types, and settings of utility company's overcurrent protective devices.
 - e. Special overcurrent protective device settings or types stipulated by utility company.
 - f. Time-current-characteristic curves of devices indicated to be coordinated.
 - g. Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
 - h. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
 - i. Panelboards, switchboards, ampacity, and interrupting rating in amperes rms symmetrical.

3.02 FAULT-CURRENT STUDY

- A. Calculate the maximum available short-circuit current in amperes rms symmetrical at circuit-breaker positions of the electrical power distribution system. The calculation shall be for a current immediately after initiation and for a three-phase bolted short circuit at each of the following:
 1. Distribution panelboard.
 2. Branch circuit panelboard.
- B. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Include studies of system-switching configurations and alternate operations that could result in maximum fault conditions.
- C. Calculate momentary and interrupting duties on the basis of maximum available fault current.
- D. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with IEEE 241 and IEEE 242.
 1. Transformers:

- a. ANSI C57.12.22.
 - b. IEEE C57.12.00.
 - c. IEEE C57.96.
 2. Low-Voltage Circuit Breakers: IEEE 1015 and IEEE C37.20.1.
 3. Low-Voltage Fuses: IEEE C37.46.
 - E. Study Report:
 1. Show calculated X/R ratios and equipment interrupting rating (1/2-cycle) fault currents on electrical distribution system diagram.
 - F. Equipment Evaluation Report:
 1. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
 2. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in the standards to 1/2-cycle symmetrical fault current.
 3. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
- 3.03 COORDINATION STUDY
- A. Perform coordination study using approved computer software program. Prepare a written report using results of fault-current study. Comply with IEEE 399.
 1. Calculate the maximum and minimum 1/2-cycle short-circuit currents.
 2. Calculate the maximum and minimum interrupting duty (5 cycles to 2 seconds) short-circuit currents.
 3. Calculate the maximum and minimum ground-fault currents.
 - B. Comply with IEEE 241 and IEEE 242 recommendations for fault currents and time intervals.
 - C. Transformer Primary Overcurrent Protective Devices:
 1. Device shall not operate in response to the following:
 - a. Inrush current when first energized.
 - b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
 - c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.
 2. Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.
 - D. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and conductor melting curves in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of

the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.

- E. Coordination-Study Report: Prepare a written report indicating the following results of coordination study:
1. Tabular Format of Settings Selected for Overcurrent Protective Devices:
 - a. Device tag.
 - b. Relay-current transformer ratios; and tap, time-dial, and instantaneous-pickup values.
 - c. Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings.
 - d. Fuse-current rating and type.
 - e. Ground-fault relay-pickup and time-delay settings.
 2. Coordination Curves: Prepared to determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:
 - a. Device tag.
 - b. Voltage and current ratio for curves.
 - c. Three-phase and single-phase damage points for each transformer.
 - d. No damage, melting, and clearing curves for fuses.
 - e. Cable damage curves.
 - f. Transformer inrush points.
 - g. Maximum fault-current cutoff point.
- F. Completed data sheets for setting of overcurrent protective devices.

END OF SECTION 26 05 73

SECTION 26 05 74**LOW VOLTAGE ARC FLASH HAZARD ANALYSIS**

PART 1 - GENERAL

1.01 SUMMARY

- A. The scope of this document is to provide requirements for providing a low voltage (600 volts and below) Arc Flash Hazard Analysis and documentation.

1.02 REQUIREMENTS

- A. A low voltage Arc Flash Hazard Analysis shall be provided for this project. The analysis shall be based on the specific equipment installed, and shall be updated to include project "as built" documentation. Where the arc flash hazard/risk category is equal to or greater than level 3, the overcurrent protective device coordination study should be reviewed to reduce the hazard/risk level. The analysis shall be based on the specific devices installed and include (but not be limited to) the following:
1. Service Entrance Equipment.
 - a. All overcurrent protective devices installed in service entrance panels.
 2. Feeder Circuits.
 - a. All three (3) phase Branch circuit overcurrent protective devices installed with a rating equal to or greater than 30 amps.
 3. Branch Circuits.
 - a. All three (3) phase Branch circuit overcurrent protective devices installed with a rating equal to or greater than 30 amps.
 - b. All motor circuit overcurrent protective devices for motors with a rating equal to or greater than 10 horse power.
- B. The project shall include printed waterproof labels for equipment that lists the specific arc flash hazard/risk category at each location.
- C. Format
1. A preliminary Arc Flash Hazard Analysis shall be submitted to the Engineer no later than three (3) weeks after the overcurrent protective device shop drawings have been approved.
 2. The Arc Flash Hazard Analysis shall be reviewed and updated to reflect any changes and corrections to conductor length within one week of the final electrical walk through for punchlist. The low voltage arc flash hazard analysis shall include the stamp or seal and signature of the preparing engineer, and shall be reviewed and approved by the Engineer of Record.
 3. Engineer approved Arc Flash Hazard warning labels shall be furnished and installed prior to project completion.

4. The low voltage arc flash hazard analysis shall be provided using the SKM Systems Analysis, Inc. SKM Power Tools Electrical Engineering Software (PTW 32).
5. Prior to project completion, the low voltage arc flash hazard analysis shall be provided in both hard copy and on computer disk. The hard copy shall clearly show each device set point. The computer disk shall include the complete coordination file including all device curves (use the SKM "Project-Backup" command).

END OF SECTION 26 05 74

SECTION 26 08 10**SYSTEMWIDE ELECTRICAL TESTING FOR SYSTEMS****PART 1 - GENERAL****1.1 SUMMARY**

- A. This Section includes the testing requirements for DIVISION 26 Systemwide Electrical. Included are tests for conductors and electrical material where required in other sections of this Division. This Section shall govern the testing requirement for all groundings required per SECTION 26 05 26.13 Systemwide Electrical Grounding For Systems.

1.2 RELATED SECTIONS

- A. SECTION 01 43 00 – Systems Quality Assurance
- B. SECTION 26 05 00.13 – Systemwide Electrical General Requirements for Systems
- C. SECTION 26 05 26.13 – Systemwide Electrical Grounding for Systems

1.3 REFERENCED STANDARDS

- A. National Electrical Testing Association (NETA)
1. NETA ATS Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems
- B. Institute of Electrical and Electronics Engineers (IEEE)
1. IEEE 81 Guide for Measuring Ground Impedance of a Ground System

1.4 QUALITY ASSURANCE/QUALITY CONTROL

- A. Quality Assurance/Quality Control shall be carried out in accordance with the requirements of S 01 43 00 Systems Quality Assurance, except as modified herein.
- B. The tests shall be performed by a company, or agency, employed by the Contractor and Approved by the Engineer. Once such a company or agency is approved, they shall not be discharged or otherwise replaced by the Contractor without Approval by the Engineer.
- C. The testing company, agency, or qualified personnel shall be regularly engaged in the field of electrical testing. The employees assigned to the project shall be personnel experienced with electrical testing procedures, electrical instrumentation, and general electrical networks. Testing personnel shall be capable of modifying the procedures specified herein to suit actual field conditions should such modifications become necessary. The testing personnel shall be NETA certified and have at least 5 years of experience in construction acceptance testing.

- D. The number of readings taken to determine an electrical constant or property must be sufficient to assure that random factors due to human error in reading the instruments and transient disturbances in the electrical network have negligible influence on the final results. The adequacy of the data can generally be established by the tester. The data shall be examined to see that removal of either the highest or lowest value will not alter the arithmetic average of the group by more than 5%. If the average is altered by more than 5%, one more set of data shall be taken and the results combined with the first set. If the average of the combined data is still altered by more than 5%, by removal of the highest or lowest value, an unstable condition might exist, and the Engineer shall be notified.
- E. Where called out, testing shall be performed by a certified NETA technician, in accordance with NETA standards.

1.5 SUBMITTALS

- A. Submittals shall be in accordance with the requirements of SECTION 26 05 00.13 Systemwide Electrical General Requirements For Systems, except as modified herein.
- B. Items required to be submitted by the Contractor for Approval include, but are not limited to, the following:
 - 1. Test reports (five copies) within 14 days after completion of each test.
 - 2. Name and qualifications of the testing consultant(s) to be used for this work. Include the full background data of the proposed testing consultant(s), including references to prior work or projects having requirements and/or complexities similar to this project. Include the names and qualifications of the senior engineering and management personnel to be used, both for field and office Work.
 - 3. Detailed written description of the proposed testing plan for a preliminary review and Approval by the Engineer. The Engineer will witness the field tests.
 - 4. List of instruments to be used for the electrical testing. The list shall include the manufacturer's name, model number, serial number and calibration certificate for each instrument. The calibration certificate shall show that each instrument was calibrated by an independent agency within the previous 12 months.
 - 5. Test data sheet showing the proposed format for test data documentation. Weather conditions, including temperature and precipitation during actual testing, shall be documented and submitted with the test results. All test data and calculations shall be submitted to the Engineer for review and Approval.

PART 2 - PRODUCTS

2.1 MEGOHMMETER AND EARTH TESTER

- A. High voltage insulation tester and three-point ground resistance tester shall be subject to the Engineer's Approval.

2.2 MISCELLANEOUS TOOLS

- A. As required for opening test facilities, making wire connections, splicing, etc.

PART 3 - EXECUTION

3.1 WITNESS TESTING

- A. Notify the Engineer prior to performing any test.

- B. The Engineer may witness any and all testing.
- C. Ground resistance test shall not be performed within 24 hours of rainfall or snowfall.

3.2 GROUND RODTEST

- A. Test each new isolated ground rod to determine the ground resistance when the water table elevation is low. The grounding test shall be in accordance with IEEE Standard 81, fall of potential test method. A plot of ground resistance readings for each isolated ground rod or ground mat shall be provided to the Engineer on 8-1/2 x 11 inch graph paper. The current-reference rod shall be driven at least 100 feet from the ground rod or grid under test. Alternatively, an established metallic ground may be used. The measurements shall be made at 10 foot intervals beginning 25 feet from the test electrode and ending 75 feet from it, in direct line between the ground rod and the current reference electrode.
- B. A grounding system that shows greater than 25 Ohm resistance for the flat portion of the plotted data shall be considered inadequately grounded. Add additional, parallel-connected ground rods 10 feet away and/or deeper-driven rods until the ground resistance measurements meet the 25 Ohm requirement. Notify the Engineer for instruction if the measured ground resistance still exceeds 25 Ohms after three additional ground rods have been added and connected. Ground rods required over that specified will be paid for as extra Work. Use of salts, water or compounds to attain the specified ground resistance is not acceptable. Refer to Communications, Overhead Contact System or Traction Power Specifications for respective grounding requirements.
- C. Testing under Subsection 3.2 shall be performed by a Certified NETA Technician in accordance with NETA Standards.

3.3 FALL OF POTENTIAL TEST

- A. Test each new isolated ground rod to determine the ground resistance when the water table elevation is low. The grounding test shall be in accordance with IEEE Standard 81, fall of potential test method. A plot of ground resistance readings for each isolated ground rod or ground mat shall be provided to the Engineer on 8-1/2 x 11 inch graph paper. The current-reference rod shall be driven at least 100 feet from the ground rod or grid under test. Alternatively, an established metallic ground may be used. The measurements shall be made at 10 foot intervals beginning 25 feet from the test electrode and ending 75 feet from it, in direct line between the ground rod and the current reference electrode.
- B. A grounding system that shows greater than specified resistance for the flat portion of the plotted data shall be considered inadequately grounded. Add additional, parallel-connected ground rods 10 feet away and/or deeper-driven rods until the ground resistance measurements meet the specified requirement. Notify the Engineer for instruction if the measured ground resistance still exceeds the specified resistance after three additional ground rods have been added and connected. Ground rods required over that specified will be paid for as extra Work. Use of salts, water or compounds to attain the specified ground resistance is not acceptable. Refer to Communications, Overhead Contact System or Traction Power Specifications for respective grounding requirements.

3.4 MEGGER TEST

- A. Perform insulation resistance (megger) test across each connection point where non-metallic fence section connects to a metallic fence section. Confirm that there is no electrical continuity and a minimum resistance of 500 Ohms.

PART 4 - MEASUREMENT AND PAYMENT**4.1 MEASUREMENT**

A. The quantities of accepted work will be measured in the following units. All measurements will be plan measure except for authorized changes.

1. Description: Lump Sum

4.2 PAYMENT

A. Payment will be made at the respective unit or lump-sum price listed in the proposal and shall be full compensation for all labor, materials, and equipment necessary to complete the respective unit in place. There will be no separate measurement or payment for any item of work not specifically identified and listed in the proposal, and all such work shall be considered a subsidiary item with all costs pertaining thereto included in the prices for other items listed in the proposal. At the Engineer's option, partial payment may be made for any lump sum item listed in the proposal, providing that the Contractor is diligently and satisfactorily pursuing full completion of such partially complete item in accordance with the approved job progress schedule.

END OF SECTION

SECTION 26 09 23
LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
1. Time switches
 2. Photoelectric switches.
 3. Indoor occupancy sensors.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.

1.03 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.04 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data

PART 2 - PRODUCTS

2.01 TIME SWITCHES

- A. Provide time switch as indicated on drawings, or approved equal.
- B. B.Electronic Time Switches: Solid state, programmable, with alphanumeric display; complying with UL 917.
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 2. Contact Configuration: DPST.
 3. Contact Rating: 30-A inductive or resistive, 277-V ac.
 4. Programs: Eight on-off set points on a 24-hour schedule and an annual holiday schedule that overrides the weekly operation on holidays.
 5. Programs: Two on-off set points on a 24-hour schedule, allowing different set points for each day of the week and an annual holiday schedule that overrides the weekly operation on holidays.

6. Circuitry: Allow connection of a photoelectric relay as substitute for on-off function of a program on selected channels.
7. Astronomic Time: All channels.
8. Automatic daylight savings time changeover.
9. Battery Backup: Not less than seven days reserve, to maintain schedules and time clock.

2.02 OUTDOOR PHOTOELECTRIC SWITCHES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 1. Cooper Industries, Inc.
 2. Intermatic, Inc.
 3. NSi Industries LLC; TORK Products.
 4. Tyco Electronics; ALR Brand.
- B. Description: Solid state, with SPST dry contacts rated for 1800 VA, to operate connected load, complying with UL 773.
 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 2. Light-Level Monitoring Range: 1.5 to 10 fc, with an adjustment for turn-on and turn-off levels within that range.
 3. Time Delay: Thirty-second minimum, to prevent false operation.
 4. Lightning Arrester: Air-gap type.
 5. Mounting: Twist lock complying with NEMA C136.10, with base.

2.03 INDOOR OCCUPANCY SENSORS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 1. Bryant Electric; a Hubbell company.
 2. Cooper Industries, Inc.
 3. Hubbell Building Automation, Inc.
 4. Leviton Mfg. Company Inc.
 5. Lightolier Controls.
 6. Lithonia Lighting; Acuity Lighting Group, Inc.
 7. Lutron Electronics Co., Inc.
 8. NSi Industries LLC; TORK Products.
 9. RAB Lighting.
 10. Sensor Switch, Inc.
 11. Square D; a brand of Schneider Electric.
 12. Watt Stopper.
- B. General Requirements for Sensors: Wall- or ceiling-mounted, solid-state indoor occupancy sensors with a separate power pack.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 2. Operation: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
 3. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor is powered from the power pack.
 4. Power Pack: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.
 5. Mounting:
 - a. Sensor: Suitable for mounting in any position on a standard outlet box.
 - b. Relay: Externally mounted through a 1/2-inch knockout in a standard electrical enclosure.
 - c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
 6. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.
 7. Bypass Switch: Override the ON or OFF function.
 8. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc; turn lights off when selected lighting level is present.
- C. Dual-Technology Type: Ceiling mounted; detect occupants in coverage area using PIR and ultrasonic detection methods. The particular technology or combination of technologies that control on-off functions is selectable in the field by operating controls on unit.
1. Sensitivity Adjustment: Separate for each sensing technology.
 2. Detector Sensitivity: Detect occurrences of 6-inch- minimum movement of any portion of a human body that presents a target of not less than 36 sq. in., and detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.
 3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on a 96-inch- high ceiling.

2.04 LIGHTING CONTRACTORS

- A. Description: Electrically operated and electrically held, combination-type lighting contactors with nonfused disconnect, complying with NEMA ICS 2 and UL 508.
1. Current Rating for Switching: Listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballast with 15 percent or less total harmonic distortion of normal load current).
 2. Fault Current Withstand Rating: Equal to or exceeding the available fault current at the point of installation.
 3. Enclosure: Comply with NEMA 250.
 4. Provide with control and pilot devices as indicated on Drawings, matching the NEMA type specified for the enclosure.

2.05 CONDUCTORS AND CABLES

- A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.
- B. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting sensors to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.
 - 1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit City's operations.
- C. Wiring Method: Comply with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size is 1/2 inch.
- D. Identify components and power and control wiring according to Division 26 Section "Identification for Electrical Systems."

3.02 FIELD QUALITY CONTROL

- A. Evaluate lighting control devices and perform tests and inspections.
- B. Perform the following tests and inspections:
 - 1. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Lighting control devices will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

END OF SECTION 26 09 23

SECTION 26 22 00
LOW-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes the following types of dry-type transformers rated 600 V and less, with capacities up to 1000 kVA:
 - 1. Distribution transformers.
 - 2. Buck-boost transformers.

1.02 ACTION SUBMITTALS

- A. Product Data: For each product indicated.
- B. Shop Drawings: Indicate dimensions and weights.
 - 1. Wiring Diagrams: Power, signal, and control wiring.

1.03 INFORMATIONAL SUBMITTALS

- A. Field quality-control test reports.

1.04 CLOSEOUT SUBMITTALS

- A. Refer to section 01 78 23 Operation and Maintenance data.

1.05 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with IEEE C57.12.91, "Test Code for Dry-Type Distribution and Power Transformers."

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. ACME Electric Corporation; Power Distribution Products Division.
 - 2. Challenger Electrical Equipment Corp.; a division of Eaton Corp.
 - 3. Controlled Power Company.
 - 4. Eaton Electrical Inc.; Cutler-Hammer Products.
 - 5. Federal Pacific Transformer Company; Division of Electro-Mechanical Corp.
 - 6. General Electric Company.
 - 7. Hammond Co.; Matra Electric, Inc.
 - 8. Magnetek Power Electronics Group.
 - 9. Micron Industries Corp.
 - 10. Myers Power Products, Inc.
 - 11. Siemens Energy & Automation, Inc.
 - 12. Sola/Hevi-Duty.
 - 13. Square D; Schneider Electric.

2.02 GENERAL TRANSFORMER REQUIREMENTS

- A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.
- B. Cores: Grain-oriented, non-aging silicon steel.
- C. Coils: Continuous windings without splices except for taps.
 - 1. Internal Coil Connections: Brazed or pressure type.
 - 2. Coil Material: Copper.

2.03 DISTRIBUTION TRANSFORMERS

- A. Comply with NEMA ST 20, and list and label as complying with UL 1561.

PART 3 - Delete first paragraph below if seismic bracing is not required. Coordinate with Parts 1 and 3.

- A. Cores: One leg per phase.
- B. Enclosure: Ventilated, NEMA 250, Type 2.
 - 1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.

- C. Enclosure: Ventilated, NEMA 250, Type 3R.
 - 1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.
- D. Transformer Enclosure Finish: Comply with NEMA 250.
 - 1. Finish Color: Gray.
- E. Taps for Transformers Smaller Than 3 kVA: None.
- F. Taps for Transformers 7.5 to 24 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity.
- G. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity.
- H. Insulation Class: 220 deg C, UL-component-recognized insulation system with a maximum of 115 deg C rise above 40 deg C ambient temperature.
- I. Energy Efficiency for Transformers Rated 15 kVA and Larger:
 - 1. Complying with NEMA TP 1, Class 1 efficiency levels.
 - 2. Tested according to NEMA TP 2.
- J. Electrostatic Shielding: Each winding shall have an independent, single, full-width copper electrostatic shield arranged to minimize interwinding capacitance.
- K. Wall Brackets: Manufacturer's standard brackets.

3.02 BUCK-BOOST TRANSFORMERS

- A. Description: Self-cooled, two-winding dry type, rated for continuous duty and with wiring terminals suitable for connection as autotransformer. Transformers shall comply with NEMA ST 1 and shall be listed and labeled as complying with UL 506 or UL 1561.
- B. Enclosure: Ventilated, NEMA 250, Type 2.
 - 1. Finish Color: Gray.

PART 4 - EXECUTION

4.01 INSTALLATION

- A. Install wall-mounting transformers level and plumb with wall brackets fabricated by transformer manufacturer.
- B. Construct concrete bases and anchor floor-mounting transformers according to manufacturer's written instructions and requirements in Division 26 Section "Hangers and Supports for Electrical Systems."

4.02 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

4.03 ADJUSTING

- A. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.
- B. Connect buck-boost transformers to provide nameplate voltage of equipment being served, plus or minus 5 percent, at secondary terminals.
- C. Output Settings Report: Prepare a written report recording output voltages and tap settings.

END OF SECTION 26 22 00

SECTION 26 24 13**SWITCHBOARDS**

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Service and distribution switchboards rated 600 V and less.
2. Transient voltage suppression devices.
3. Disconnecting and overcurrent protective devices.
4. Instrumentation.
5. Control power.
6. Accessory components and features.
7. Identification.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For each switchboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings.
2. Include time-current coordination curves for each type and rating of overcurrent protective device included in switchboards.
3. Include schematic and wiring diagrams for power, signal, and control wiring.

1.03 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.04 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.05 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NEMA PB 2.

- C. Comply with NFPA 70.
- D. Comply with UL 891.

1.06 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 MANUFACTURED UNITS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D; a brand of Schneider Electric.
- B. Front-Connected, Front-Accessible Switchboards:
 - 1. Main Devices: Fixed, individually mounted.
 - 2. Branch Devices: Panel mounted.
 - 3. Sections front and rear aligned.
- C. Nominal System Voltage: As indicated on plans.
- D. Main-Bus Continuous: Refer to plans.
- E. Enclosure: Steel, NEMA 250, Type 1.
 - 1. Enclosure Finish: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.
 - 2. Enclosure: Flat roof; bolt-on rear covers for each section, with provisions for padlocking.
- F. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.
- G. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.
- H. Pull Box on Top of Switchboard:

1. Adequate ventilation to maintain temperature in pull box within same limits as switchboard.
 2. Removable covers shall form top, front, and sides. Top covers at rear shall be easily removable for drilling and cutting.
 3. Bottom shall be insulating, fire-resistive material with separate holes for cable drops into switchboard.
 4. Cable supports shall be arranged to facilitate cabling and adequate to support cables indicated, including those for future installation.
- I. Phase and Neutral Buses and Connections: Three phase, four wire unless otherwise indicated. Hard drawn copper of 98% conductivity with copper circuit-breaker line connections.
1. Ground Bus: 1/4-by-2-inch- minimum size, hard-drawn copper of 98 percent conductivity, equipped with pressure connectors for feeder and branch-circuit ground conductors.
 2. Main Phase Buses and Equipment Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.
 3. Neutral Buses: 100 percent of the ampacity of phase buses unless otherwise indicated, equipped with pressure connectors for outgoing circuit neutral cables.
- J. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.

2.02 TRANSIENT VOLTAGE SUPPRESSION DEVICES

- A. Surge Protection Device Description: IEEE C62.41-compliant, integrally mounted, solid-state, parallel-connected, with sine-wave tracking suppression and filtering modules, UL 1449, third edition, short-circuit current rating matching or exceeding the switchboard short-circuit rating, and with the following features and accessories:
1. Fuses, rated at 200-kA interrupting capacity.
 2. LED indicator lights for power and protection status.
 3. Audible alarm, with silencing switch, to indicate when protection has failed.
 4. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of system operation. Contacts shall reverse position on failure of any surge diversion module or on opening of any current-limiting device.
 5. Transient-event counter set to totalize transient surges.
- B. Peak Single-Impulse Surge Current Rating: 160 kA per mode/320 kA per phase.
- C. Withstand Capabilities: 5000 IEEE C62.41, Category C3 (10 kA), 8-by-20-mic.sec. surges with less than 5 percent change in clamping voltage.
- D. Protection modes and UL 1449 SVR for grounded wye circuits with three-phase, four-wire circuits shall be as follows:
1. Line to Neutral: 800V for 480V and 400 V for 208V.
 2. Line to Ground: 800V for 480V and 400 V for 208V.
 3. Neutral to Ground: 800V for 480V and 400 V for 208V.

2.03 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Branch Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity indicated on plans.
1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 100 A and larger.
 2. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Lugs: Compression style, suitable for number, size, trip ratings, and conductor material.
 - c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
 - d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 - e. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
 - f. Communication Capability: Integral communication module with functions and features compatible with power monitoring and control system specified in Section 26 09 13 "Electrical Power Monitoring and Control."
 - g. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.
 - h. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
 - i. Auxiliary Contacts: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
 - j. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
- B. Main Insulated-Case Circuit Breaker (ICCB): 100 percent rated, sealed, insulated-case power circuit breaker with interrupting capacity rating to meet available fault current.
1. Fixed circuit-breaker mounting.
 2. Two-step, stored-energy closing.
 3. Standard-function, microprocessor-based trip units with interchangeable rating plug, trip indicators, and the following field-adjustable settings:
 - a. Instantaneous trip.
 - b. Long- and short-time time adjustments.
 - c. Ground-fault pickup level, time delay, and I^2t response.
 4. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
 5. Remote trip indication and control.
 6. Communication Capability: Integral communication module with functions and features compatible with power monitoring and control system specified in Section 26 09 13 "Electrical Power Monitoring and Control."

7. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
 8. Control Voltage: 120-V ac.
- C. Bolted-Pressure Contact Switch: Operating mechanism uses rotary-mechanical-bolting action to produce and maintain high clamping pressure on the switch blade after it engages the stationary contacts.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Boltswitch, Inc.
 - b. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - c. Pringle Electrical Manufacturing Company, Inc.
 - d. Siemens Energy & Automation, Inc.
 - e. Square D; a brand of Schneider Electric.
 2. Operating Mechanism: Manual handle operation to close switch; stores energy in mechanism for opening and closing.
 - a. Electrical Trip: Operation of lever or push-button trip switch, or trip signal from ground-fault relay or remote-control device, causes switch to open.
 - b. Mechanical Trip: Operation of mechanical lever, push button, or other device causes switch to open.
 3. Auxiliary Switches: Factory installed, single pole, double throw, with leads connected to terminal block, and including one set more than quantity required for functional performance indicated.
 4. Service-Rated Switches: Labeled for use as service equipment.
 5. Ground-Fault Relay: Comply with UL 1053; self-powered type with mechanical ground-fault indicator, test function, tripping relay with internal memory, and three-phase current transformer/sensor.
 - a. Configuration: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 6. Open-Fuse Trip Device: Arranged to trip switch open if a phase fuse opens.

2.04 INSTRUMENTATION

- A. Instrument Transformers: IEEE C57.13, NEMA EI 21.1, and the following:
1. Current Transformers: IEEE C57.13; 5 A, 60 Hz, secondary and secondary shorting device. Burden and accuracy shall be consistent with connected metering and relay devices.
 2. Control-Power Transformers: Dry type, mounted in separate compartments for units larger than 3 kVA.
 3. Current Transformers for Neutral and Ground-Fault Current Sensing: Connect secondary wiring to ground overcurrent relays, via shorting terminals, to provide selective tripping of main and tie circuit breaker. Coordinate with feeder circuit-breaker, ground-fault protection.

- B. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:
1. Switch-selectable digital display of the following values with maximum accuracy tolerances as indicated:
 - a. Phase Currents, Each Phase: Plus or minus 1 percent.
 - b. Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
 - c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
 - d. Megawatts: Plus or minus 2 percent.
 - e. Megavars: Plus or minus 2 percent.
 - f. Power Factor: Plus or minus 2 percent.
 - g. Frequency: Plus or minus 0.5 percent.
 - h. Accumulated Energy, Megawatt Hours: Plus or minus 2 percent; accumulated values unaffected by power outages up to 72 hours.
 - i. Megawatt Demand: Plus or minus 2 percent; demand interval programmable from five to 60 minutes.
 2. Mounting: Display and control unit flush or semiflush mounted in instrument compartment door.

2.05 CONTROL POWER

- A. Control Circuits: 120-V ac, supplied through secondary disconnecting devices from control-power transformer.
- B. Control-Power Fuses: Primary and secondary fuses for current-limiting and overload protection of transformer and fuses for protection of control circuits.
- C. Control Wiring: Factory installed, with bundling, lacing, and protection included. Provide flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

2.06 ACCESSORY COMPONENTS AND FEATURES

- A. Portable Test Set: For testing functions of solid-state trip devices without removing from switchboard. Include relay and meter test plugs suitable for testing switchboard meters and switchboard class relays.

2.07 IDENTIFICATION

- A. Service Equipment Label: NRTL labeled for use as service equipment for switchboards with one or more service disconnecting and overcurrent protective devices.

PART 3 - EXECUTION**3.01 INSTALLATION**

- A. Receive, inspect, handle, store and install switchboards and accessories according to NECA 400.
- B. Equipment Mounting: Install switchboards on concrete base, 4-inch nominal thickness. Comply with requirements for concrete base specified in Section 03 30 00 "Cast-in-Place Concrete."
 - 1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
 - 2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 - 3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 4. Install anchor bolts to elevations required for proper attachment to switchboards.
- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchboard units and components.
- D. Install filler plates in unused spaces of panel-mounted sections.
- E. Install overcurrent protective devices, transient voltage suppression devices, and instrumentation.
 - 1. Set field-adjustable switches and circuit-breaker trip ranges.
- F. Comply with NECA 1.
- G. Comply with requirements for terminating feeder bus specified in Section 26 25 00 "Enclosed Bus Assemblies." Drawings indicate general arrangement of bus, fittings, and specialties.

3.02 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."
- B. Switchboard Nameplates: Label each switchboard compartment with a nameplate complying with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."
- C. Device Nameplates: Label each disconnecting and overcurrent protective device and each meter and control device mounted in compartment doors with a nameplate complying with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

3.03 FIELD QUALITY CONTROL

- A. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.

- B. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 - 3. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

- C. Switchboard will be considered defective if it does not pass tests and inspections.

- D. Prepare test and inspection reports, including a certified report that identifies switchboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

END OF SECTION 26 24 13

SECTION 26 24 16**PANELBOARDS**

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes distribution panelboards and lighting and appliance branch-circuit panelboards.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For each panelboard and related equipment.
 - 1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
 - 2. Detail enclosure types and details for types other than NEMA 250, Type 1.
 - 3. Detail bus configuration, current, and voltage ratings.
 - 4. Short-circuit current rating of panelboards and overcurrent protective devices.
 - 5. Include evidence of NRTL listing for series rating of installed devices.
 - 6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
 - 7. Include wiring diagrams for power, signal, and control wiring.
 - 8. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards.

1.03 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.
- B. Panelboard schedules for installation in panelboards.

1.04 CLOSEOUT SUBMITTALS

- A. Refer to Section 01 78 23 "Operation and maintenance data".

1.05 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

- B. Comply with NEMA PB 1.
- C. Comply with NFPA 70.

1.06 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS FOR PANELBOARDS

- A. Enclosures: Flush- and surface-mounted cabinets.
 - 1. Rated for environmental conditions at installed location.
 - a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
 - b. Outdoor Locations: NEMA 250, Type 3R.
 - c. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
 - 2. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.
 - 3. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
 - 4. Directory Card: Inside panelboard door, mounted in transparent card holder.
- B. Incoming Mains Location: Top and bottom.
- C. Phase, Neutral, and Ground Buses: Hard-drawn copper, 98 percent conductivity.
- D. Conductor Connectors: Suitable for use with conductor material and sizes.
 - 1. Material: Hard-drawn copper, 98 percent conductivity.
 - 2. Main and Neutral Lugs: Compression type.
 - 3. Ground Lugs and Bus Configured Terminators: Compression type.
 - 4. Feed-Through Lugs: Compression type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
 - 5. Subfeed (Double) Lugs: Compression type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
- E. Service Equipment Label: NRTL labeled for use as service equipment for panelboards with one or more main service disconnecting and overcurrent protective devices.
- F. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

- G. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.02 DISTRIBUTION PANELBOARDS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D; a brand of Schneider Electric.
- B. Panelboards: NEMA PB 1, power and feeder distribution type.
- C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
- D. Mains: Circuit breaker.
- E. Branch Overcurrent Protective Devices: For Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.
- F. Branch Overcurrent Protective Devices: For Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers.

2.03 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D; a brand of Schneider Electric.
- B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.
- C. Mains: Circuit breaker and or main lugs only as indicated on plans.
- D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
- E. Contactors in Main Bus: NEMA ICS 2, Class A, electrically held, general-purpose controller, with same short-circuit interrupting rating as panelboard.
 - 1. External Control-Power Source: 120-V branch circuit.
- F. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

2.04 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 3. Siemens Energy & Automation, Inc.
 4. Square D; a brand of Schneider Electric.
- B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.
1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 100 A and larger.
 2. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
 3. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
 4. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
 5. Arc-Fault Circuit Interrupter (AFCI) Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.
 6. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Lugs: Compression style, suitable for number, size, trip ratings, and conductor materials.
 - c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
 - d. Communication Capability: Circuit-breaker-mounted communication module with functions and features compatible with power monitoring and control system specified in Division 26 Section "Electrical Power Monitoring and Control."
 - e. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in on position.
 - f. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.

2.05 ACCESSORY COMPONENTS AND FEATURES

- A. Portable Test Set: For testing functions of solid-state trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.

PART 3 - EXECUTION**3.01 INSTALLATION**

- A. Receive, inspect, handle, store and install panelboards and accessories according to NECA 407.
- B. Mount top of trim 90 inches above finished floor unless otherwise indicated.
- C. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
- D. Install overcurrent protective devices and controllers not already factory installed.
 - 1. Set field-adjustable, circuit-breaker trip ranges.
- E. Install filler plates in unused spaces.
- F. In ceiling areas stub four 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch empty conduits into raised floor space or below slab not on grade.
- G. Arrange conductors in gutters into groups and bundle and wrap with wire ties.
- H. Comply with NECA 1.

3.02 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Division 26 Section "Identification for Electrical Systems."
- B. Create a directory to indicate installed circuit loads and incorporating City's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.
- C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
- D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.03 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Acceptance Testing Preparation:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
 2. Test continuity of each circuit.
- C. Tests and Inspections:
1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
- D. Panelboards will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

END OF SECTION 26 24 16

SECTION 26 27 26**WIRING DEVICES****PART 1 - GENERAL****1.01 SUMMARY****A. Section Includes:**

1. Receptacles, receptacles with integral GFCI, and associated device plates.
2. Weather-resistant receptacles.
3. Snap switches and wall-box dimmers.
4. Wall-switch and exterior occupancy sensors.
5. Communications outlets.

1.02 ADMINISTRATIVE REQUIREMENTS**A. Coordination:**

1. Receptacles for Owner-Furnished Equipment: Match plug configurations.

1.03 ACTION SUBMITTALS**A. Product Data:** For each type of product.**B. Shop Drawings:** List of legends and description of materials and process used for premarking wall plates.**1.04 INFORMATIONAL SUBMITTALS****A. Field quality-control reports.****1.05 CLOSEOUT SUBMITTALS****A. Operation and maintenance data.****PART 2 - PRODUCTS****2.01 MANUFACTURERS****A. Manufacturers' Names:** Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:

1. Cooper Wiring Devices; Division of Cooper Industries, Inc. (Cooper).

2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
3. Leviton Mfg. Company Inc. (Leviton).
4. Pass & Seymour/Legrand (Pass & Seymour).
5. Or approved equal.

- B. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.02 GENERAL WIRING-DEVICE REQUIREMENTS

- A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.
- C. Devices that are manufactured for use with modular plug-in connectors may be substituted under the following conditions:
1. Connectors shall comply with UL 2459 and shall be made with stranding building wire.
 2. Devices shall comply with the requirements in this Section.

2.03 STRAIGHT-BLADE RECEPTACLES

- A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cooper; 5351 (single), CR5362 (duplex).
 - b. Hubbell; HBL5351 (single), HBL5352 (duplex).
 - c. Leviton; 5891 (single), 5352 (duplex).
 - d. Pass & Seymour; 5361 (single), 5362 (duplex).

2.04 GFCI RECEPTACLES

- A. General Description:
1. Straight blade, non-feed-through type.
 2. Comply with NEMA WD 1, NEMA WD 6, UL 498, UL 943 Class A, and FS W-C-596.
 3. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.
- B. Duplex GFCI Convenience Receptacles, 125 V, 20 A:
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cooper; VGF20.

- b. Hubbell; GFR5352L.
- c. Pass & Seymour; 2095.
- d. Leviton; 7590.

2.05 TOGGLE SWITCHES

- A. Comply with NEMA WD 1, UL 20, and FS W-S-896.
- B. Switches, 120/277 V, 20 A:
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Single Pole:
 - 1) Cooper; AH1221.
 - 2) Hubbell; HBL1221.
 - 3) Leviton; 1221-2.
 - 4) Pass & Seymour; CSB20AC1.
 - b. Two Pole:
 - 1) Cooper; AH1222.
 - 2) Hubbell; HBL1222.
 - 3) Leviton; 1222-2.
 - 4) Pass & Seymour; CSB20AC2.
 - c. Three Way:
 - 1) Cooper; AH1223.
 - 2) Hubbell; HBL1223.
 - 3) Leviton; 1223-2.
 - 4) Pass & Seymour; CSB20AC3.

2.06 DECORATOR-STYLE DEVICES

- A. Toggle Switches, Square Face, 120/277 V, 15 A: Comply with NEMA WD 1, UL 20, and FS W-S-896.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cooper; 7621 (single pole), 7623 (three way).
 - b. Hubbell; DS115 (single pole), DS315 (three way).
 - c. Leviton; 56291-2 (single pole), 5623-2 (three way).
 - d. Pass & Seymour; 2621 (single pole), 2623 (three way).

2.07 WALL PLATES

- A. Single and combination types shall match corresponding wiring devices.
 - 1. Plate-Securing Screws: Metal with head color to match plate finish.

2. Material for Finished Spaces: Steel with white baked enamel, suitable for field painting.
 3. Material for Unfinished Spaces: Galvanized steel.
 4. Material for Damp Locations: Thermoplastic with spring-loaded lift cover, and listed and labeled for use in wet and damp locations.
- B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant thermoplastic with lockable cover.

2.08 FINISHES

- A. Device Color: As selected by Architect.
- B. Wall Plate Color: As selected by Architect.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Comply with NECA 1.
- B. For mounting heights of devices, refer to Architectural Plan 2A001.
- C. Coordination with Other Trades:
 1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
 2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
 3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
 4. Install wiring devices after all wall preparation, including painting, is complete.
- D. Conductors:
 1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
 2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
 3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
 4. Existing Conductors:
 - a. Cut back and pigtail, or replace all damaged conductors.
 - b. Straighten conductors that remain and remove corrosion and foreign matter.

- c. Pigtailing existing conductors is permitted, provided the outlet box is large enough.

E. Device Installation:

1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.

F. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the right.

G. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

H. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

I. Adjust locations of service poles to suit arrangement of partitions and furnishings.

3.02 GFCI RECEPTACLES

- A. Install non-feed-through-type GFCI receptacles where protection of downstream receptacles is not required.

3.03 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Test Instruments: Use instruments that comply with UL 1436.
2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.

- B. Tests for Convenience Receptacles:
1. Line Voltage: Acceptable range is 105 to 132 V.
 2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.
 3. Ground Impedance: Values of up to 2 ohms are acceptable.
 4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
 5. Using the test plug, verify that the device and its outlet box are securely mounted.
 6. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.
- C. Wiring device will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

END OF SECTION 26 27 26

SECTION 26 28 16**ENCLOSED SWITCHES AND CIRCUIT BREAKERS**

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Fusible switches.
 - 2. Nonfusible switches.
 - 3. Enclosures.

1.02 DEFINITIONS

- A. NC: Normally closed.
- B. NO: Normally open.
- C. SPDT: Single pole, double throw.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated.
- B. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Wiring Diagrams: For power, signal, and control wiring.

1.04 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.05 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.06 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

- B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.01 FUSIBLE SWITCHES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 3. Siemens Energy & Automation, Inc.
 4. Square D; a brand of Schneider Electric.
- B. Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- C. Type HD, Heavy Duty, Six Pole, Single Throw, 600-V ac, 200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- D. Type HD, Heavy Duty, Double Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- E. Accessories:
1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
 4. Lugs: Suitable for number, size, and conductor material.

2.02 NONFUSIBLE SWITCHES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 3. Siemens Energy & Automation, Inc.
 4. Square D; a brand of Schneider Electric.

- B. Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- C. Type HD, Heavy Duty, Six Pole, Single Throw, 600-V ac, 200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- D. Type HD, Heavy Duty, Double Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- E. Accessories:
 - 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
 - 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 - 3. Lugs: Suitable for number, size, and conductor material.

2.03 ENCLOSURES

- A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
 - 1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
 - 2. Outdoor Locations: NEMA 250, Type 3R.
 - 3. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.
 - 4. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
- B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- C. Install fuses in fusible devices.
- D. Comply with NECA 1.

3.02 IDENTIFICATION

- A. Comply with requirements in Division 26 Section "Identification for Electrical Systems."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.03 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Acceptance Testing Preparation:
 1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.
 2. Test continuity of each circuit.
- C. Tests and Inspections:
 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
- D. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports, including a certified report that identifies enclosed switches and circuit breakers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

END OF SECTION 26 28 16

SECTION 26 29 13
ENCLOSED CONTROLLERS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes the following enclosed controllers rated 600 V and less:
 - 1. Full-voltage magnetic.

1.02 DEFINITIONS

- A. CPT: Control power transformer.
- B. MCCB: Molded-case circuit breaker.
- C. MCP: Motor circuit protector.
- D. N.C.: Normally closed.
- E. N.O.: Normally open.
- F. OCPD: Overcurrent protective device.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of enclosed controller.
- B. Shop Drawings: For each enclosed controller. Include dimensioned plans, elevations, sections, details, and required clearances and service spaces around controller enclosures.
 - 1. Wiring Diagrams: For power, signal, and control wiring.

1.04 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.05 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.06 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.01 ENCLOSURES

- A. Enclosed Controllers: NEMA ICS 6, to comply with environmental conditions at installed location.
 - 1. Dry and Clean Indoor Locations: Type 1.
 - 2. Outdoor Locations: Type 3R.
 - 3. Other Wet or Damp Indoor Locations: Type 4.
 - 4. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: Type 12.

2.02 ACCESSORIES

- A. Push Buttons, Pilot Lights, and Selector Switches: NEMA ICS 5; heavy-duty type; factory installed in controller enclosure cover unless otherwise indicated.
- B. Control Relays: Auxiliary and adjustable time-delay relays.
- C. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections. Provide adjustable undervoltage, overvoltage, and time-delay settings.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Wall-Mounted Controllers: Install enclosed controllers on walls with tops at uniform height, and with disconnect operating handles not higher than 79 inches above finished floor, unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks complying with Division 26 Section "Hangers and Supports for Electrical Systems."
- B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- C. Install fuses in each fusible-switch enclosed controller.

- D. Install fuses in control circuits if not factory installed. Comply with requirements in Division 26 Section "Fuses."
- E. Install heaters in thermal overload relays. Select heaters based on actual nameplate full-load amperes after motors have been installed.
- F. Comply with NECA 1.

3.02 IDENTIFICATION

- A. Identify enclosed controllers, components, and control wiring. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
 - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 - 2. Label each enclosure with engraved nameplate.
 - 3. Label each enclosure-mounted control and pilot device.

3.03 CONTROL WIRING INSTALLATION

- A. Bundle, train, and support wiring in enclosures.
- B. Connect selector switches and other automatic-control selection devices where applicable.
 - 1. Connect selector switches to bypass only those manual- and automatic-control devices that have no safety functions when switch is in manual-control position.
 - 2. Connect selector switches with enclosed-controller circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.04 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each enclosed controller, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- C. Tests and Inspections:
 - 1. Inspect controllers, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
 - 2. Test insulation resistance for each enclosed-controller element, component, connecting motor supply, feeder, and control circuits.
 - 3. Test continuity of each circuit.

4. Verify that voltages at controller locations are within plus or minus 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify City before starting the motor(s).
 5. Test each motor for proper phase rotation.
 6. Perform each electrical test and visual and mechanical inspection stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 8. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Enclosed controllers will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.05 ADJUSTING

- A. Set field-adjustable switches and overload-relay pickup and trip ranges.
- B. Adjust the trip settings of MCPs and thermal-magnetic circuit breakers with adjustable instantaneous trip elements. Initially adjust to six times the motor nameplate full-load ampere ratings and attempt to start motors several times, allowing for motor cooldown between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify City before increasing settings.

3.06 DEMONSTRATION

- A. Train City's maintenance personnel to adjust, operate, and maintain enclosed controllers.

END OF SECTION 26 29 13

SECTION 26 41 13**LIGHTNING PROTECTION FOR STRUCTURES**

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes lightning protection for building.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For air terminals and mounting accessories.
 - 1. Layout of the lightning protection system, along with details of the components to be used in the installation.
 - 2. Include indications for use of raceway, data on how concealment requirements will be met, and calculations required by NFPA 780 for bonding of grounded and isolated metal bodies.

1.03 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.04 QUALITY ASSURANCE

- A. Installer Qualifications: Certified by LPI as a Master Installer/Designer, trained and approved for installation of units required for this Project.
- B. System Certificate:
 - 1. UL Master Label.
 - 2. LPI System Certificate.
 - 3. UL Master Label Recertification.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 780, "Definitions" Article.

PART 2 - PRODUCTS

2.01 LIGHTNING PROTECTION SYSTEM COMPONENTS

- A. Comply with UL 96 and NFPA 780.

- B. Roof-Mounted Air Terminals: NFPA 780, Class I, aluminum unless otherwise indicated.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. East Coast Lightning Equipment Inc.
 - b. ERICO International Corporation.
 - c. Harger.
 - d. Heary Bros. Lightning Protection Co. Inc.
 - e. Independent Protection Co.
 - f. Preferred Lightning Protection.
 - g. Robbins Lightning, Inc.
 - h. Thompson Lightning Protection, Inc.
 - 2. Air Terminals More than 24 Inches (600 mm) Long: With brace attached to the terminal at not less than half the height of the terminal.
 - 3. Single-Membrane, Roof-Mounted Air Terminals: Designed specifically for single-membrane roof system materials. Comply with requirements in roofing Sections.
- C. Main and Bonding Conductors: Copper.
- D. Ground Loop Conductor: The same size and type as the main conductor except tinned.
- E. Ground Rods: Copper-clad steel, sectional type; 3/4 inch (19 mm) in diameter by 10 feet (3 m) long.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install lightning protection components and systems according to UL 96A and NFPA 780.
- B. Conceal the following conductors:
 - 1. System conductors.
 - 2. Down conductors.
 - 3. Interior conductors.
 - 4. Conductors within normal view of exterior locations at grade.
- C. Cable Connections: Use crimped or bolted connections for all conductor splices and connections between conductors and other components. Use exothermic-welded connections in underground portions of the system.
- D. Air Terminals on Single-Ply Membrane Roofing: Comply with roofing membrane and adhesive manufacturer's written instructions.
- E. Bond extremities of vertical metal bodies exceeding 60 feet (18 m) in length to lightning protection components.

- F. Ground Loop: Install ground-level, potential equalization conductor and extend around the perimeter of building.
 - 1. Bury ground ring not less than 24 inches (600 mm) from building foundation.
 - 2. Bond ground terminals to the ground loop.
 - 3. Bond grounded building systems to the ground loop conductor within 12 feet (3.6 m) of grade level.
- G. Bond lightning protection components with intermediate-level interconnection loop conductors to grounded metal bodies of building at 60-foot (18-m) intervals.

3.02 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 26 05 44 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.03 CORROSION PROTECTION

- A. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture unless moisture is permanently excluded from junction of such materials.
- B. Use conductors with protective coatings where conditions cause deterioration or corrosion of conductors.

3.04 FIELD QUALITY CONTROL

- A. Notify Engineer at least 48 hours in advance of inspection before concealing lightning protection components.
- B. UL Inspection: Meet requirements to obtain a UL Master Label for system.
- C. LPI System Inspection: Meet requirements to obtain an LPI System Certificate.

END OF SECTION 26 41 13

SECTION 26 42 10**TRACK SLAB ELECTRICAL CONTINUITY****PART 1 - GENERAL****1.1 SUMMARY**

- A. Provide a stray current collector system including electrical continuity of the track slab reinforcing steel, permanent test stations for measuring electrical continuity and stray current levels, embedded monitoring components, grounding beds for discharge of stray current, adequate cabling size for short circuit conditions, jumper cables for track slab expansion joints and other electrical discontinuities, and all other Work required to provide complete functioning systems.
- B. This section applies to the supply, installation, and testing of all materials and components necessary for construction of the track slab stray current collection and monitoring systems.

1.2 SUBMITTALS

- A. Submittals shall be made in accordance with SECTION 01 33 00 – Submittal Procedures, except as modified herein.
- B. The Submittals required by this section are summarized below. They are described in detail at the reference location.
 - 1. Testing Firm Qualifications (Ref. 1.04C)
 - 2. Product Data (Ref. 2.01A)
 - 3. Track Slab Electrical Continuity Work Plan (Ref. 3.01A)
 - 4. Test Instrumentation (Ref. 3.03A2)
 - 5. Pre-Embedment Continuity Test Procedure (Ref. 3.03B)
 - 6. Post-Embedment Continuity Test Procedure (Ref. 3.03C)
 - 7. Test Station Verification Test Procedure (Ref. 3.03D)
 - 8. Ground Rod to Earth Resistance Test Procedure (Ref. 3.03E)
 - 9. Pre-Embedment Continuity Test Results (Ref. 3.03B)
 - 10. Post-Embedment Continuity Test Results (Ref. 3.03C)
 - 11. Test Station Verification Test Results (Ref. 3.03D)
 - 12. Ground Rod to Earth Resistance Test Results (Ref. 3.03E)

1.3 QUALITY CONTROL

- A. Utilize an independent corrosion control firm to conduct all testing of the track slab stray current collection system.

- B. The independent corrosion control firm shall have been continuously engaged in the field of corrosion control testing for DC electrified transit systems for a minimum of five years and shall have the following qualifications:
1. Project management and supervision by Registered Professional Corrosion Engineers or NACE International Certified Cathodic Protection Specialists.
 2. Field testing by NACE International Certified Corrosion Technicians and Cathodic Protection Specialists.
 3. Testing personnel shall have at least five years of work experience with testing trackwork stray current and corrosion control systems.
 4. All test equipment shall bear current calibration stickers.
- C. At least thirty days prior to commencement of work, submit testing firm qualifications for Approval, including resumes and certifications for all testing personnel and supervisors.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Submit information for all components and materials, including name and manufacturer, catalog number, size, finish, material characteristics, and any other data necessary for proper identification and to verify conformance with the Contract.

2.2 TRANSVERSE BONDING BARS

- A. Transverse bonding bars shall be standard reinforcing steel as specified for the structural components of the bridge or track slab, equal in size to the longitudinal reinforcement.

2.3 WELDING RODS

- A. Welding rods for electrical continuity welding of the longitudinal lap splices and the transverse bonding bars shall be manufactured in accordance with AWS A-5.1 and shall be compatible with the specified reinforcing steel.

2.4 BONDING CABLES

- A. Stranded copper, AWG No. 1/0 cable with 600 Volt, THWN insulation. Provide appropriate lengths to accommodate maximum design deflections of the joints or structural elements.

2.5 TEST CABLES

- A. Stranded copper, AWG No. 10 cable with 600 Volt, THWN insulation.

2.6 TEST STATIONS

- A. Track slab test stations: Brooks Type 1RT, or approved equal, with phenolic panel board.
- B. Bridge test stations: NEMA 4X, Fiberglass Reinforced Plastic, with stainless steel hardware, Hoffman HJ1210HWPL2LG or approved equal.

2.7 REFERENCE ELECTRODES

- A. Silver/silver-chloride reference electrode with one AWG No. 12 test lead with 600 Volt, THWN insulation: Electrochemical Devices, Inc. Model CB-AGG-CW or approved equal. Lead wires shall extend from the electrode location to the test station location with no splices.

2.8 REBAR PROBES

- A. Custom configuration with two AWG No. 12 test leads with 600 Volt THWN insulation: Electrochemical Devices, Inc. or approved equal. Lead wires shall extend from the embedded probe location to the test station with no splices.

PART 3 - EXECUTION**3.1 GENERAL**

- A. Submit for Approval a comprehensive work plan containing necessary details and procedures related to the planning, construction and testing of the track slab stray current collection system. The submittal shall include drawings which indicate the proposed locations for all transverse bonding bars, test station access boxes, ground rods, and other system components.

3.2 TRACK SLAB ELECTRICAL CONTINUITY

- A. Bottom layer longitudinal reinforcement shall be electrically bonded by welding at the lap joints as shown on the drawings. Bottom layer longitudinal reinforcement shall be made electrically continuous for the entire length of the track slab segment. The electrical resistance of the bottom layer reinforcing steel shall be a maximum of 20% above the calculated longitudinal resistance of the number of installed parallel reinforcing bars in parallel.
- B. Transverse bonding bars shall be installed at each end of the track slab segment and at intermediate locations not to exceed 500 feet. Transverse bonding bars shall be welded to each bottom layer longitudinal reinforcement bar as shown in the drawings. The transverse bonding bar shall be a single bar from end to end.
- C. Track slab expansion joints shall be bonded for electrical continuity through the use of bonding cables, as shown in the drawings. Provide sufficient bonding cables at each location based upon fault condition requirements.
- D. Drain and test lead wires shall be attached to the transverse bonding bars at locations shown on the drawings. Drain and test lead wire attachment shall be made by welding a steel lead rod to the transverse bonding bar, as shown on the drawings.
- E. The silver/silver chloride reference electrode and rebar probe assembly shall be pre-assembled prior to installation. Install the prefabricated assembly at the required locations by welding the frame assembly to the transverse bonding bar, as shown on the drawings.
- F. Ground rods shall be installed as shown on the drawings. The drain cable shall be attached to each ground rod by the use of a mechanical clamp assembly.
- G. Permanent test stations for the stray current collection system shall be installed at the required locations. Test stations shall be located so that they are accessible during rail operations and do not interfere with automobile traffic when accessed for testing.

3.3 TESTING

- A. General
 - 1. Submit for Approval detailed written descriptions of the proposed stray current collection system testing schedules and testing procedures identified herein. Testing procedure submittals shall include the proposed format for test data collection forms.

2. Submit for Approval information regarding all stray current collection system testing instruments. The instrumentation submittal shall include the manufacturer's name, model number, serial number and calibration certificate for each instrument.
 3. Submit for Approval all stray current collection system testing data, records, calculations, results and reports. Test submittals shall include sufficient information so that the results are identifiable and traceable to installed components or locations.
- B. Conduct the Pre-Embedment Continuity Test to verify electrical continuity of each track slab segment prior to placement of concrete.
1. Establish two connections to each transverse collector bar at each end of the section to be tested. Each connection will be verified by measuring the millivolt difference between the two connections at each end. If the voltage measured between the two connection points is less than 1.0 millivolt, the connections can be considered adequate. If the voltage measured between the two connection points measures in excess of 1.0 millivolt, the connections need to be re-worked until an acceptable reading is obtained. A reading in excess of 1.0 millivolt can indicate an electrical discontinuity between the two connection points.
 2. Establish a test current circuit between one connection point at each end of the section to be tested (I1), using a 12 Volt automotive battery or similar power supply.
 3. Establish a voltage measuring circuit between one connection point at each end of the section to be tested (E1). The voltage and current circuits shall utilize different connection points to eliminate lead resistance errors.
 4. With the current circuit (I1) closed, reduce the meter ranges of both circuits until the lowest readable scales are reached. Read and record the "on" values for current and voltage.
 5. Open the current circuit (I1) and immediately read and record the "off" values for current and voltage. Repeat a minimum of three times for accuracy.
 6. Calculate the effective resistance of the reinforcing steel by dividing the summation of change in voltage, $\Sigma\Delta E1$, by the summation of change in current, $\Sigma\Delta I1$.
 7. $R1-1 = \Sigma\Delta E1/\Sigma\Delta I1$ (volt/ampere)
 8. This resistance value represents the resistance of the reinforcement section under test.
 9. The calculated resistance (R1-1) shall be compared with a theoretical value of resistance for the subject test section. The theoretical value of the subject test section shall be computed by calculating the resistance network of the reinforcing bars and bond cables associated with the subject test section. The measured resistance of the test section shall not be greater than the calculated resistance multiplied by 1.2.
 10. The temperature of the reinforcing steel shall be measured and recorded at the start and end of each continuity test. The calculated resistance values shall be compensated for the temperature during the test period.
- C. Conduct the Post-Embedment Continuity Test to verify electrical continuity of each track slab segment after placement of concrete. The test procedure shall be identical to the procedure for the Pre-Embedment Continuity Test, except that the measurements shall be taken between test stations.

- D. Conduct Test Station Verification Test to verify that all required test stations are provided and that all test and drain cables are properly installed. Perform this test at the same time as the Post-Embedment Continuity Test.
 - 1. Verify proper labeling and termination of all test station cables.
 - 2. Test electrical continuity of all test and drain cables.
- E. Ground Rod to Earth Resistance Test
 - 1. Stray current discharge ground mats shall be tested for resistance-to-earth by the fall of potential method described in IEEE Standard 80.
 - 2. The maximum ground rod-to-earth resistance shall be 5 ohms.
 - 3. Additional ground rods shall be installed as necessary to meet the 5 ohm criteria.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

- A. The quantities of accepted work will be measured in the following units. All measurements will be plan measure except for authorized changes.
 - 1. Description: Lump Sum

4.2 PAYMENT

- 1. Payment will be made at the respective unit or lump-sum price listed in the proposal and shall be full compensation for all labor, materials, and equipment necessary to complete the respective unit in place. There will be no separate measurement or payment for any item of work not specifically identified and listed in the proposal, and all such work shall be considered a subsidiary item with all costs pertaining thereto included in the prices for other items listed in the proposal. At the Engineer's option, partial payment may be made for any lump sum item listed in the proposal, providing that the Contractor is diligently and satisfactorily pursuing full completion of such partially complete item in accordance with the approved job progress schedule.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 26 42 12**TRACKWORK ELECTRICAL ISOLATION****PART 1 - GENERAL****1.1 SUMMARY**

- A. This section addresses the requirements for electrical isolation of track, including ballasted track, embedded track, direct fixation track, special trackwork, and insulated rail joints.
- B. Provide all materials, equipment and labor necessary to complete the Work shown on the Contract Drawings and described herein, and any additional requirements necessary for completion of an acceptable track isolation system.

1.2 SUBMITTALS

- A. Submittals shall be made in accordance with the requirements of SECTION 01 33 00 SUBMITTAL PROCEDURES, except as modified herein.
- B. The Submittals required by this section are summarized below. They are described in detail at the reference location.
 - 1. Testing Firm Qualifications (Ref. 1.04D)
 - 2. Rail Boot Quality Assurance Certification (Ref. 1.04E)
 - 3. Product Data, Material Specifications and Shop Drawings (Ref. 2.01B)
 - 4. Test Instrumentation (Ref. 3.06A2)
 - 5. Rail Boot Fabrication Holiday Test Procedure (Ref. 3.06B)
 - 6. Rail Boot Installation Holiday Test Procedure (Ref. 3.06C)
 - 7. Rail Insulating Joint Test Procedure (Ref. 3.06D)
 - 8. Track-to-Earth Resistance Test Procedure (Ref. 3.06E)
 - 9. Rail Boot Fabrication Holiday Test Results (Ref. 3.06B)
 - 10. Rail Boot Installation Holiday Test Results (Ref. 3.06C)
 - 11. Rail Insulating Joint Test Results (Ref. 3.06D)
 - 12. Track-to-Earth Resistance Test Results (Ref. 3.06E)

1.3 QUALITY CONTROL

- A. Utilize an independent corrosion control firm to conduct all testing of the trackwork electrical isolation system.
- B. The independent corrosion control firm shall have been continuously engaged in the field of corrosion control testing for DC electrified transit systems for a minimum of five years and shall have the following qualifications:
 - 1. Project management and supervision by Registered Professional Corrosion Engineers or NACE International Certified Cathodic Protection Specialists.

2. Field testing by NACE International Certified Corrosion Technicians and Cathodic Protection Specialists.
 3. Designated supervisor shall have at least ten years of corrosion control experience, and successful experience of being in responsible charge of work comparable in type and quality to that specified herein.
 4. Testing personnel shall have at least five years of work experience with testing trackwork electrical isolation systems.
 5. All test equipment shall bear current calibration stickers.
- C. The designated corrosion control supervisor shall conduct or directly supervise all on-site testing specified herein.
- D. At least thirty days prior to commencement of work, submit testing firm qualifications for Approval, including resumes and certifications for all testing personnel and supervisors.
- E. Submit certification of quality assurance testing compliance from the rail boot manufacturer.

PART 2 - PRODUCTS

2.1 GENERAL

- A. All materials shall conform to the requirements set forth herein or as designated on the drawings, unless otherwise specified. All materials must be new, free from defects, and shall be of the best commercial quality for the purpose specified. Furnish all necessary items and accessories not shown on the drawings or specified herein, but which are required to fully carry out the specified intent of the Work.
- B. Submit product data, material specifications and shop drawings for all trackwork isolation materials, components and assemblies.

2.2 RAIL BOOT

- A. The rail boot shall be manufactured to fit the rail size as specified in the related trackwork construction specifications. The rail boot shall extend around the rail as shown on the drawings. The rail boot shall be extruded as a dual durometer unit with the rail flange edges and the grade edges extruded with a durometer hardness of Shore D-50, min.
- B. The rail boot shall meet the requirements specified in Section 34 11 29 of these specifications.

2.3 JOINING CUFFS

- A. Joining cuffs shall be manufactured from the same material as the rail boot and shall exhibit the same properties as listed in the rail boot section. The cuffs shall be a minimum of 12 inches in length for all rail boot butt splices. Repair cuffs for rail boot damage shall extend a minimum of 6 inches to each side of a rail boot defect.

2.4 ELASTOMERIC GROUT

- A. Elastomeric grout shall be as specified in Section 34 11 29 and shall exhibit a volume resistivity of 1×10^{12} ohm-centimeters minimum when cured.

2.5 JOINING CUFF ADHESIVE/SEALANT

- A. The joining cuff adhesive/sealant shall be a one-component moisture curing polyurethane sealant.
- B. Sonneborn, type NP-1 or approved equal.

2.6 RAIL CLIP INSULATOR

- A. The rail clip insulators shall be a nylon insulator sized to fit the specific rail base profile and rail clip assemblies.

2.7 RAIL PADS

- A. The rail pads for standard tie and ballast trackwork shall exhibit mechanical properties as required in the trackwork specification section and an electrical resistivity of 1×10^{12} ohm-centimeters in accordance with ASTM D-257.

PART 3 - EXECUTION**3.1 GENERAL**

- A. Fabricate and install trackwork isolation system to provide the following minimum track-to-earth resistance levels:
 - 1. Embedded Track 200 Ohms per 1000 Track Feet
 - 2. Ballasted and Direct Fixation Track 500 Ohms per 1000 Track Feet
- B. Embedded standard track shall utilize a complete rail encapsulation methodology (rail boot) to obtain the required track-to-earth resistance level.
- C. Special trackwork sections shall be insulated from the track slab using insulated anchors on the rail plates and an insulating elastomer between the track slab and the rail.
- D. Rail cable bonds and rail-mounted devices in embedded trackwork shall be electrically isolated within a rail access box.

3.2 STORAGE OF MATERIALS

- A. All materials and equipment to be used in construction shall be stored in such a manner to be protected from detrimental effects from the elements. If warehouse storage cannot be provided, materials and equipment shall be stacked well above ground level and protected from the elements with plastic sheeting or as appropriate.

3.3 RAIL BOOT

- A. The rail boot shall be installed in accordance with the manufacturer's recommendations and as described herein.
- B. The rail boot shall only be installed on clean rail free of dirt and debris. The inside of the rail boot shall be inspected to insure that no rocks, dirt, or other construction debris has fallen into the boot which could cause a puncture.
- C. The boot shall be installed to minimize the number of splice joints required in any length of trackwork.

- D. Extreme care shall be exhibited during all phases of construction with the rail boot. The handling of the boot spools, installation, movement of the rail, installation of the track slab reinforcement and reinforcement welding operations shall be conducted in a manner that will not damage the boot.
- E. The boot shall be held in place with non-conductive tape in accordance with the manufacturer's recommendation.
- F. The use of tie-wire or any metallic hangers against the boot shall be strictly prohibited.
- G. The rail boot shall be installed on the specified ties in the embedded trackwork sections of this project.
- H. The adjustment of the rail by the use of alignment bars against the boot is strictly prohibited. If alignment of the rail is necessary after installation of the boot, wood blocks or other means of contact dissipation shall be used to minimize a concentrated force against the boot.
- I. Holiday testing is required after the initial installation of the rail boot and after the installation of the track slab reinforcement.

3.4 JOINING CUFF

- A. The joining cuff shall be installed at rail boot joints on clean and dry surfaces. The exterior portion of the boot that will be covered by the cuff and the interior of the joining cuff shall be roughened with a wire brush to allow for better adhesion between the cuff and the rail boot. A generous application of polyurethane adhesive/sealant shall be applied to the interior of the cuff and the joining cuff shall be installed and held in place by non-conductive tape until the concrete pour.

3.5 ELASTOMERIC GROUT

- A. Elastomeric grout shall be applied in accordance with the manufacturer's recommendations in areas where the boot must be removed or eliminated.

3.6 TESTING

- A. General
 - 1. Submit for Approval detailed written descriptions of the proposed trackwork isolation testing schedules and testing procedures identified herein. Testing procedure submittals shall include the proposed format for test data collection forms.
 - 2. Submit for Approval information regarding all trackwork isolation testing instruments. The instrumentation submittal shall include the manufacturer's name, model number, serial number and calibration certificate for each instrument. The calibration certificate shall demonstrate that each instrument has been calibrated by an independent agency within 1 year of start of testing. Each instrument shall have a current calibration certification and no instrument shall be used unless calibrated.
 - 3. Submit for Approval all trackwork isolation testing data, records, calculations, results and reports. Test submittals shall include sufficient information so that the results are identifiable and traceable to installed components or locations.

- B. High Voltage Electrical Boot Test (Fabrication Test)
1. The rail boot shall be tested for flaws and damage during the manufacturing process. The manufacturer of the rail boot shall implement high voltage electrical testing using a high voltage holiday detector set at a minimum voltage of 30,000 volts DC. The boot shall be 100% tested as it exits the extrusion machine. All identified flaws shall be removed from the boot material to be shipped to the project site. The electrical testing shall utilize a D. E. Stearns model 10/20 Holiday Detector or approved equal.
- C. High Voltage Electrical Boot Test (Installation Test)
1. The rail boot shall be 100% tested for flaws and damage, during installation, using a high voltage holiday detector at a minimum voltage of 30,000 volts DC. The testing shall be conducted immediately after placement on the rail and again after placement of the track slab reinforcement and formwork. Special attachments may be necessary to insure complete coverage of the high voltage wand over the entire surface of the boot. Any flaws identified in the boot shall be repaired by the use of an exterior cuff applied with an approved adhesive/sealant. The electrical testing shall utilize a D.E. Stearns model 10/20 Holiday Detector or approved equal.
- D. Conduct the Rail Insulating Joint Test at all insulated joint locations prior to the connection of impedance bonds.
1. Measure the resistance between each side of the insulating joint and the joint bar and the resistance across the insulating joint.
 2. Measure the voltage shift of the rail to earth on both sides of the insulating joint while applying a test current to one side of the insulating joint during track-to-earth resistance testing. Also measure the voltage shift across the insulating joint.
- E. Track-to-Earth Resistance Test
1. The track-to-earth resistance testing shall be conducted for all trackwork constructed for this project. Two test methods are described to measure the required track-to-earth resistance, depending on the trackwork configuration encountered during the test. Sections of trackwork shall be tested in maximum increments of 2,000 track feet.
 2. Method 1: Track-to-earth resistance test method 1 is applicable to electrically separated sections of trackwork. Conduct this testing in accordance with ASTM G-165.
 3. Method 2: Track-to-earth resistance test method 2 is applicable to electrically interconnected sections of trackwork. Conduct this testing in accordance with ASTM G-165. For equipment and measurement requirements use the following procedure:
 - a. Establish a current circuit (I1) between the track system and a low resistant earth contact and a track-to-earth voltage measuring circuit (Vg1) using a low resistance earth contact. The voltage circuit earth contact shall not be the same as the earth contact used in the current circuit.
 - b. With the current circuit (I1) closed, reduce the meter ranges of both circuits until the lowest readable scales are reached. Read and record the "on" values for current and voltage.
 - c. Open the current circuit (I1) and immediately read and record the "off" values for current and voltage. Repeat a minimum of three times for accuracy.

- d. Calculate the effective track-to-earth resistance by dividing the summation of change in voltage, $Vg1$, by the summation of change in current, $I1$.

$$Rvg1-1 = \Sigma \Delta Vg1 / \Sigma \Delta I1 \text{ (volt/ampere)}$$

- e. This resistance value represents the apparent resistance of the track section under test in parallel with the adjacent track sections. Usually the composite resistance to earth of the adjacent track sections will be lower than that of the test section because of the greater amount of trackage involved.

- f. Obtain additional track-to-earth couplings at other locations as required.

$$Rvg2-1 = \Sigma \Delta Vg2 / \Sigma \Delta I1 = \text{volt/ampere}$$

$$Rvg3-1 = \Sigma \Delta Vg3 / \Sigma \Delta I1 = \text{volt/ampere}$$

- g. Maintaining the current circuit ($I1$), measure the percentage of change in current flow on the rail at the locations specified using a maximum of 50 feet of rail as a current measuring shunt. The current percentage shall be calculated as follows:

$$\%IA-1 = (\Sigma \Delta EA \times KR \times 100) / \Sigma \Delta I1$$

Where:

$\%IA-1$ = percentage of $I1$ at location "A"

$\Sigma \Delta EA$ = summation of change in EA caused by $I1$, for the total number of readings taken (millivolts).

$\Sigma \Delta I1$ = summation of change in $I1$ for the total number of readings taken (amperes)

KR = conversion factor for the millivolt shunt circuit (amperes/millivolt)

$$KR = 1 / (L \times RR \times 1000 \text{ mv/v})$$

L = length of rail used for the millivolt shunt circuit (feet)

RR = longitudinal resistance of running rail per one foot length (ohms/foot)

Note: Using the theoretical resistance value of 8.68×10^{-6} ohm/foot for 115RE rail, the theoretical KR value for a 50 foot span of single rail is:

$$KR = 2.30 \text{ amperes/millivolt (115RE rail)}$$

(A sufficient sampling of actual longitudinal resistance factors must be measured to establish a statistical mean value for KR used in the preceding calculations.)

- h. Obtain current flow percentages at the locations specified. Calculate the following:

$$\%IB-1 = (\Sigma \Delta EB \times KR \times 100) / \Sigma \Delta I1$$

$$\%IC-1 = (\Sigma \Delta EC \times KR \times 100) / \Sigma \Delta I1$$

$$\%ID-1 = (\Sigma \Delta ED \times KR \times 100) / \Sigma \Delta I1$$

$$\%IE-1 = (\Sigma\Delta EE \times KR \times 100) / \Sigma\Delta I1$$

$$\%IF-1 = (\Sigma\Delta EF \times KR \times 100) / \Sigma\Delta I1$$

$$\%IG-1 = (\Sigma\Delta EG \times KR \times 100) / \Sigma\Delta I1$$

$$\%IH-1 = (\Sigma\Delta EH \times KR \times 100) / \Sigma\Delta I1 \text{ and}$$

$$\%IS-1 = \%IA-1 + \%IB-1 + \%IC-1 + \%ID-1$$

$$\%IR-1 = \%IE-1 + \%IF-1 + \%IG-1 + \%IH-1$$

(A significant difference between the values obtained for %IA-1 through %ID-1 and/or between the values obtained for %IE-1 through %IH-1 may indicate that the electrical conductance-to-earth is not uniform over the entire track section being evaluated.)

- i. Calculate the average resistance-to-earth of the test section

$$RAVG = (RVg1-1 + RVg2-1 + RVg3-1) / 3(\%IS-1 - \%IR-1)$$

Where:

%IS-1 and %IR-1 must be expressed as decimals

- j. Calculate the average track-to-earth resistance for the test section on a 1000 foot of track basis (2 rails).

$$RT = RAVG \times L \times 2 = \text{ohms-1000-feet of track (2 rails)}$$

Where:

L = Length of track in multiples of 1000 feet

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

- A. The quantities of accepted work will be measured in the following units. All measurements will be plan measure except for authorized changes.

1. Description: Lump Sum

4.2 PAYMENT

- A. Payment will be made at the respective unit or lump-sum price listed in the proposal and shall be full compensation for all labor, materials, and equipment necessary to complete the respective unit in place. There will be no separate measurement or payment for any item of work not specifically identified and listed in the proposal, and all such work shall be considered a subsidiary item with all costs pertaining thereto included in the prices for other items listed in the proposal. At the Engineer's option, partial payment may be made for any lump sum item listed in the proposal, providing that the Contractor is diligently and satisfactorily pursuing full completion of such partially complete item in accordance with the approved job progress schedule.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 26 42 14**CATHODIC PROTECTION FOR NEW OR RELOCATED WATERLINES****PART 1 - GENERAL****1.1 SUMMARY**

- A. The Work specified in this Section includes the manufacturing, factory testing, delivery, installation, and site testing of the equipment and materials to be provided for cathodic protection systems for the Kansas City Downtown Streetcar Project.
- B. Cathodic protection systems are described for new and relocated buried, pressurized, metallic piping systems.

1.2 RELATED SECTIONS

- A. SECTION 01 33 00 – Submittal Procedures

1.3 REFERENCES

- A. American National Standards Institute (ANSI) B2.1
- B. American Society for Testing and Materials (ASTM) – B418, D621, D638, D648, D695, D785, D790, D1000, D1248
- C. NACE International (formerly The National Association of Corrosion Engineers) – SP0169-2007
- D. American Water Works Association (AWWA) C105
- E. National Electrical Manufacturers Association (NEMA)
- F. SAE International (formerly The Society of Automotive Engineers)
- G. Society for Protective Coatings (SSPC) – SP 2, SP 3 and SP 7
- H. United States Department of Transportation (US DOT) – 192.461

1.4 QUALITY CONTROL

- A. The Contractor shall provide the Work included in this Section in strict accordance with the requirements of the Contractor's Quality Assurance Program as Approved by the Engineer and in compliance with the requirements of these Specifications.
- B. Products and equipment – Incorporate cathodic protection products and systems into the Work that duplicate products and equipment that have been in satisfactory use for a period of at least 5 years.
- C. Supervision – Perform Work under the direction of a corrosion engineer with at least 10 years corrosion control experience and a minimum NACE International certification level of Cathodic Protection Specialist. The supervisor shall monitor the installation and testing of corrosion control products and cathodic protection and stray current systems on site, and shall have successful experience of being in responsible charge of work comparable in type and quality to that specified herein. The certified corrosion engineer shall perform or directly supervise all testing on site.

1.5 SUBMITTALS

- A. Submittals shall be made in accordance with the requirements of SECTION 01 33 00 – Submittal Procedures, except as modified herein.
- B. Product data for all corrosion control products utilized in this Section shall be submitted.
- C. Testing Procedures – The Contractor shall submit a detailed written description of the proposed testing schedule and procedures for preliminary Approval by the Engineer. Proposed modifications to the testing procedures described herein shall be submitted to the Engineer for Approval.
- D. Instrumentation – The Contractor shall submit a list of instruments to be used for the electrical testing. The list shall include the manufacturer's name, model number, serial number and calibration certificate for each instrument. The calibration certificate shall show that each instrument was calibrated by an independent agency within 1 year of start of testing. Each instrument shall have a current calibration and no instrument shall be used unless calibrated.
- E. Documentation – The Contractor shall submit a test data sheet showing the proposed format for test data documentation. All test data and calculations shall be submitted to the Engineer for each required test for review and Approval.

PART 2 - PRODUCTS

2.1 ANODES

- A. General
 - 1. Galvanic anodes shall be of the size indicated by the cathodic protection design. Each anode shall be cast with a steel core and the core shall protrude from one end and shall be of sufficient length to permit attachment of a lead wire.
 - 2. Each anode shall be furnished with a lead wire attached to one end of the steel core, and the wire shall be of sufficient length to attach to the anode terminal block as shown on the Contract Drawings. The wire shall be connected to the steel core by silver soldering, and the connection shall be mechanically secure before soldering with at least three turns of wire at the connection. The entire connection shall be insulated with an electrical potting compound. The cable attached to the anode shall be No. 12 AWG, Type TW or THWN stranded, single conductor copper.
 - 3. The anode shall be prepackaged in a permeable cloth bag filled with a mixture of 75% ground hydrated gypsum, 20% powdered bentonite, and 5% anhydrous sodium sulfate. Backfill shall have a grain size so that 100% is capable of passing through a 100-mesh screen. The mixture shall be firmly packed around the anode within the cloth bag by means of adequate vibration so that the ingot is completely surrounded with a minimum 1-inch of backfill material.

B. High Potential (HI-PO) Magnesium Anode

1. Chemical Composition

Element	Percentage
Aluminum	0.010 Maximum
Manganese	0.50 to 1.30
Copper	0.02 Maximum
Nickel	0.001 Maximum
Zinc	0.05 Maximum
Iron	0.03 Maximum
Silicon	0.05 Maximum
Other	0.05 each or 0.30 Maximum Total
Magnesium	Remainder

2.2 REFERENCE ELECTRODES

- A. Permanent copper-copper sulfate reference electrodes prepackaged in cloth bags filled with low-resistance backfill material.

2.3 POLYETHYLENE ENCASEMENT

- A. Install 8-mil polyethylene in accordance with AWWA C105.
- B. Polyethylene film shall meet the following test requirements:

Test	Requirements
Tensile Strength	1200 psi Minimum
Elongation	300% Minimum
Dielectric Strength	800 V/mil thickness Minimum
Thickness	8 mils Minimum nominal with minus tolerance not exceeding 10% of nominal
Flow Rate	0.4 Maximum

2.4 WIRE AND CABLE

- A. Anode Header Cable – Single conductor, stranded copper, sized as shown with Type TH or THWN insulation, length as shown, required, or specified herein.
- B. Test Wires – Single conductor, stranded copper, with Type TW 600 Volt insulation. Size and color as shown.
- C. Pipe Bond Wire – Single conductor stranded copper, sized as shown, with Type TH or THWN insulation. Length as shown required or specified herein.

2.5 EXOTHERMIC WELDING PROCESS

- A. Exothermic cartridge, type and size suitable for the metals being connected using properly sized molds, disks and sleeves as recommended by the manufacturer's printed materials. Exothermic weld materials and products shall be Cadweld as manufactured by Erico Products, Inc., Thermoweld, or approved equal.

2.6 WELD CAPS

- A. Self-contained combination plastic cap, with elastomeric filler and 4-inch Tac-Tape® base. Royston Handy Cap® or approved equal.
- B. High-density polyethylene weld caps to be used in conjunction with coal tar mastic to coat wire/pipe exothermic welds.

2.7 CABLE WARNING TAPE

- A. Four-inch wide, yellow, with black lettering with the legend "CAUTION, CATHODIC PROTECTION CABLES BURIED BELOW" in 3-inch high lettering printed at a maximum of 7-foot intervals along the entire length of the tape

2.8 WIRE IDENTIFICATION TAGS

- A. White plastic "zip-tie" type straps with a plastic tab of sufficient size to allow the cable designation to be written on the tab with a permanent felt tip marker.

2.9 AT-GRADE TEST BOX

- A. A.B.S. polymer body with heavy duty cast iron pentagon locking lid and flange, supplied with seven post, polyester laminate terminal block as shown, with the following additional requirements:
 - 1. The piping owner's logo and "CP TEST" shall be permanently cast on the test box lid
 - 2. Minimum internal body diameter – 5 inches
 - 3. Supply each test box with a pentagon wrench opening key
 - 4. Terminal bolts, nuts and washers – nickel plated brass, or Type 316 stainless steel

2.10 CURRENT MONITORING SHUNTS

- A. Shunt components mounted on a phenolic or other composite strip designed for use with test station terminal boards, with a rating of 0.01-Ohm, 6-Amp capacity, with 1% accuracy.

2.11 INSULATING FITTINGS

- A. Insulating Flange Kit – Supplied in complete sets from a single manufacturer, securely packaged and clearly labeled as to size, ANSI rating, style and material and with the following provisions:
 - 1. Gasket – Full faced, 1/8-inch (3 millimeters) thick neoprene coated phenolic, size and pressure rating suitable for the application and with the following additional minimum requirements:
 - a. Water Absorption – 1.6% maximum
 - b. Tensile Strength (with grain) – 13,000 psi minimum
 - c. Compressive strength (flatwise) – 39,000 psi minimum
 - d. Dielectric strength (Volts per mil) – 240 minimum

2. Sleeves – NEMA Grade LE laminated phenolic. Size and pressure rating suitable for the application and with the following additional requirements:
 - a. Length – Shall extend through both flanges and insulating washers
 - b. Thickness – 1/32 inch minimum
 - c. Dielectric Strength (Volts per mil) – 400 minimum
 - d. Water absorption – 1.1% maximum
 3. Insulating Washers – Glass mat polyester laminated phenolic, two per stud, size as required for the application, and with the following additional requirements:
 - a. Thickness – 1/8 inch (3 millimeters) minimum
 - b. Dielectric Strength (Volts per mil) – 400 minimum
 - c. Compressive Strength (flat wise) – 40,000 PSI minimum
 - d. Water absorption – 2.0% maximum
 4. Steel Washers – 1/8 inch thick, SAE zinc plated, two per stud
- B. Isolating Compression Coupling – Pre-assembled steel, compression gasket type, factory coated with 12 mils minimum thermosetting epoxy polyamide. Size, temperature and pressure rating suitable for the application, and with the following additional requirements:
1. Coating to meet DOT Federal Regulation 192.461
 2. Isolating gasket to extend entirely under the follower ring
 3. Armored gasket to bond between metal parts and protected piping
 4. Middle isolating sleeve to extend between the pipe ends
- C. Dielectric Union – High test, air refined malleable iron, complete with brass bearing ring and molded nylon insulated material. Size, temperature and pressure rating suitable for the application, and with the following additional requirements:
1. Seating surface to be extra wide ground joint type
 2. Insulating nylon to be molded to the union body to provide integral one-piece construction
 3. Threads to be precision machined meeting ANSI B2.1
- D. Service Insulators – Brass insulating fitting for connecting cathodically protected copper service piping to metallic waterlines. Size suitable for the application, with the following requirements:
1. 150 psi working pressure
 2. Threaded nylon bushing assembled between male and female flare copper adapters
 3. Ford Meter Box Company Model SI or approved equal

2.12 PIPELINE CASING INSULATORS

- A. Band – 14-gauge (.074-inch) steel, hot rolled and pickled. Two-piece through 36-inch carrier pipe size. Width of band as recommended by manufacturer as determined by carrier pipe size.
- B. PVC Liner:

Thickness	0.09-inch minimum
Hardness	Durometer “A” 85-90
Dielectric Strength (1/8 inch thick)	
- Surge Test	60,000 V
- Step by Step Test	58,000 V
Water Absorption	1% maximum
- C. Studs, Nuts and Washers – Stainless steel or cadmium plated. Number, size, and length as required by manufacturer.
- D. Runners – 2 inch wide glass reinforced plastic (G-2), height as required to center the carrier pipe within the casing pipe, and to provide permanent 1 inch minimum clearance between casing and carrier pipe couplings and hubs, and with the following additional requirements:

Characteristic	Reference	Requirement
Tensile Strength	ASTM D638	17,600 psi
Flexural Strength	ASTM D790	25,300 psi
Compression Strength (10% Deformation)	ASTM D695	18,000 psi
Deflection Temperature (@264 psi)	ASTM D648	405 degrees Fahrenheit
Deformation Under Load (@122 degrees Fahrenheit, 2,000 pound load)	ASTM D621	1.2%
- E. Finish – Synthetic enamel with rust inhibiting pigment.

2.13 CASING END SEALS

- A. Synthetic rubber with stainless steel bands for closure around casing and carrier pipes. Model “S” as manufactured by PSI, Inc., or approved equal.

2.14 SOLDER

- A. Wire-to-Copper Pipe Connection – Lead free plumbing solder suitable for sweating joints in a copper water distribution system with a melting range between 420° degrees Fahrenheit and 480 degrees Fahrenheit.
- B. Wire-to-Ring Terminal Connection – Rosin Core 60/40 (60% Tin / 40% Lead) solder suitable for electronic and electrical connections with a melting range between 360 degrees Fahrenheit and 375 degrees Fahrenheit.

2.15 COPPER U-CHANNEL

- A. Copper 1/8-inch x 5/32-inch flat U-channel for holding test wires in place while soldering to copper service piping. Channel is available from stained glass supply retailers.

PART 3 - EXECUTION**3.1 STORAGE OF MATERIALS**

- A. All corrosion control materials and equipment shall be stored in a manner that protects them from the detrimental effects of the elements. If warehouse storage cannot be provided, materials and equipment shall be stacked well above ground level and protected from the elements with plastic sheeting or as appropriate.

3.2 ANODES AND REFERENCE ELECTRODES

- A. Bury anodes of type, size and number at locations shown on the utility plans with the following additional requirements:
1. Wet prepackaged magnesium anodes thoroughly before backfilling hole.
 2. Use fine clay or native soil, free from stones, bricks and organic matter, for backfilling.
 3. Use exothermic welding process to connect anode leads to header cable as shown and route cable as shown on the Contract Drawings. Terminate cables in test boxes at the locations shown on Contract Drawings.

3.3 REFERENCE ELECTRODES

- A. Reference electrodes shall be installed in pipeline backfill material at a distance of 6 inches to 12 inches from the exterior pipeline surface. The reference electrode lead wires shall be routed to the associated test station without splices.

3.4 POLYEHTYLENE ENCASEMENT

- A. All newly installed ductile iron piping shall utilize 8-mil polyethylene encasement as described in AWWA C105.
1. Place tube of polyethylene material around pipe prior to lowering pipe into trench.
 2. Pull the tube over the length of the pipe.
 3. Tape tube to pipe at joint
 4. Fold material around the adjacent spigot end and wrap three circumferential turns of two-inch wide plastic tape to hold plastic tube
 5. Adjacent tube overlaps first tube and is secured with plastic adhesive tape. The polyethylene tube material covering the pipe will be loose.
 6. Excess material shall be neatly drawn up around the pipe barrel, folded into an overlap on top of the pipe, and held in place by means of pieces of the plastic tape at approximately three to five foot intervals.

3.5 WIRE AND CABLE

- A. Electrically bond mechanical joints on metallic piping as shown. Provide test wires of the size and type shown from each bonded facility and terminate at locations shown on the Contract Drawings. Route anode header cables and/or anode lead wires to appropriate test boxes as shown on the Contract Drawings. All wire/structure connections and buried wire and cable splices shall be exothermically welded and coated. Use of compression and split bolt connectors is prohibited. Identify each wire in test boxes using nonmetallic tags or pressure sensitive labels. Ring tongue connectors shall be attached to test wires, for connection to test box terminal board, using a crimping tool specifically designed for use with connectors.

3.6 EXOTHERMIC WELD CONNECTIONS

- A. Molds, weld metal and associated accessories shall be sized and designed for making electrical connections for copper-to-copper, copper-to-steel and copper-to-ductile iron as required.
- B. Place weld cap over completed wire/pipe exothermic welds. The edges of the weld cap shall extend over the existing pipe coating as shown and totally encapsulate the weld, exposed pipe surface, and bare wire. If weld caps with coal tar mastic are used, fill weld cap with coal tar mastic and place over weld, exposed pipe surface and bare wire.
- C. All wire and cable splices, including anode-to-header cable connections, shall be exothermically welded. Connection shall be clean and dry prior to wrapping. Completed weld shall be initially wrapped with three layers of butyl rubber splicing tape, followed by two layers of vinyl plastic tape, using 50% overlap during application.

3.7 CABLE WARNING TAPE

- A. Place cable warning tape over cathodic protection test wires and anode lead wires and/or header cables during backfilling operation. Cover wires and cables with 18 inches of compacted fill prior to placement of warning tape. Ensure warning tape is located directly over the wires prior to backfilling tape.

3.8 WIRE IDENTIFICATION TAGS

- A. Attach wire identification tags on all test wires and cathodic protection component wires a maximum of 6 inches from the terminal board connections. Tags shall be appropriately marked to identify anodes, casings, protected pipe, non-protected pipe and reference electrodes.

3.9 AT-GRADE TEST BOX

- A. Install at locations shown on the Contract Drawings. Route all wires as shown and in a manner that will not cause damage to the wire insulation. Allow enough slack to compensate for soil movements and to extend panel above grade for test access. Coil excess wire inside box. Boxes shall be placed outside of vehicular traffic lanes, and shall be accessible for performing future cathodic protection testing.

3.10 INSULATING FITTINGS

- A. Insulating Flange – Provide appropriately sized flange-to-flange joint and install insulating gasket, sleeves and washers in accordance with the manufacturer's written instructions, using all thread studs. Entire flange, exposed nuts, studs and washers shall be coated with petrolatum coating system as described in Part 3.4.A.2 of this Section.

- B. Isolating Compression Coupling – Install at locations shown on the utility plans, with insulating adapter gasket located away from cathodically protected piping. Install bond wires as shown on the cathodic protection details drawing to electrically connect coupling to cathodically protected piping. Coat all exothermic welds, bare steel and threaded rods with 24 mils DFT coal tar mastic as described in Part 3.4.A.3 of this Section.
- C. Dielectric Unions – Install as required in above ground piping applications in accordance with the manufacturer’s recommendations.
- D. Service Insulators – Install as required in buried copper service piping in accordance with the manufacturer’s recommendations. Coat entire insulator as described in Part 3.4.A.2 of this Section.

3.11 PIPELINE CASING INSULATORS

- A. Install in accordance with the manufacturer’s published instructions, and with the following requirements:
 - 1. Space one insulator 1 foot in from each casing end, and every 10 feet (maximum) thereafter.
 - 2. Additionally, place an insulator 1 foot from each side of each mechanical joint within the casing.
 - 3. All carrier pipe coating shall be tested as required to the satisfaction of the OWNER prior to installation inside the casing pipe. Damage to the pipe coating during the installation process shall be repaired to the satisfaction of the Engineer.

3.12 CASING END SEALS

- A. Install in accordance with manufacturer’s published instructions. Slide end seals over the carrier pipe at the casing entrance during carrier pipe installation. Remove dirt and debris from the carrier pipe and casing surfaces prior to positioning the seal and tightening the stainless steel bands.

3.13 SOLDER CONNECTIONS

- A. Wire-to-Copper Pipe Connection – Use lead-free plumbing solder for connecting test wires to piping. Copper service piping shall not be charged during soldering operation. If charged, drain water prior to soldering.
 - 1. Clean top pipe surface using an abrasive sanding cloth. Apply tinning flux to the cleaned surface.
 - 2. Wire-tie a one-inch length of copper U-channel over the cleaned surface parallel to the longitudinal pipe surface using steel wire
 - 3. Strip 2 inches of insulation from the test wire to be attached. Apply tinning flux to one inch of the wire away from the insulation.
 - 4. Slide wire into the U-channel leaving one inch of bare wire exposed to minimize melting of the insulation during the soldering operation.
 - 5. Apply heat from a propane torch to the pipe and U-channel until the flux bubbles and feed solder into the U-channel holding the torch at the opposite end of the U-channel.
 - 6. Remove heat and allow solder to cool. Solder, exposed wire, and bare pipe surfaces shall be coated with the same material used for coating the pipe.

- B. Wire-to-Ring Terminal Connection – Use rosin core solder for connecting wires to test station terminals.
1. Use a crimping tool specifically designed for use with the type of ring terminals used. Consult manufacturer's recommendations for appropriate crimping tool.
 2. Strip enough insulation from the test wire to extend fully into the ring terminal sleeve and crimp the terminal sleeve as required.
 3. Heat the terminal sleeve using a propane torch and feed the solder into the ring side of the sleeve. Apply enough heat to melt the solder without melting the wire insulation.
 4. Remove the heat and allow the solder to cool.

3.14 TESTING

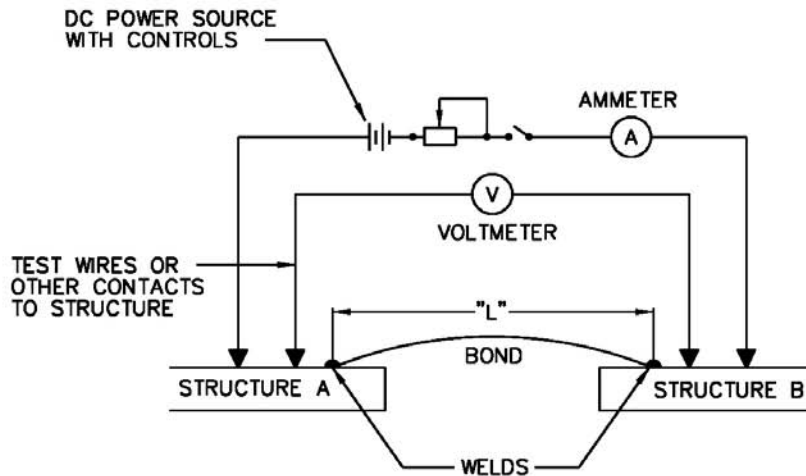
- A. Test Equipment
1. Analog DC Voltmeter – Multi-scale (1 mV to 10 Volt, or 2 mV to 20 Volt), center zero or 10% upscale, accurate to within 0.5% of full scale. Electronic Voltmeter circuit shall provide a minimum input resistance of 10 Megohms for ranges above 20 mV.
 2. Electronic DC Voltmeter (Digital Readout) – Multi-scale (20 mV to 20 Volt), accurate to within 1% of reading + 1 digit, minimum input resistance of 10 Megohms for ranges above 20 mV.
 3. Analog DC Ammeter – Multi-scale (1 mA to 10 Amp, or 2 mA to 20 Amp), center zero or 10% upscale, accurate to within 0.5% of full scale.
 4. Electronic DC Ammeter (Digital Readout) – Multi-scale (20 mA to 20 Amp), accurate to within 1% of reading + 1 digit
 5. Strip Chart Voltage Recorder – Multi-scale, AC/battery powered, with 2.5 Megohms input resistance (minimum), 0.5 second response time [full scale (maximum)], and adjustable chart speed control.
 6. Digital Voltage Recorder – Multi scale, AC/battery powered, data logger with 10 Megohms input resistance (minimum).
 7. DC Power Source – 12 Volt, sealed, rechargeable battery with a minimum 6.5-Ampere/hour capacity. For tests requiring additional current magnitudes, use two or more batteries in series, a DC generator or portable test rectifier.
 8. Test Wires – Insulated, single conductor stranded copper test leads of various sizes and lengths, with appropriate connectors to suit test conditions. At least two hand reels with approximately 500 feet of insulated, stranded copper wire (16 AWG minimum).
 9. Cu/CuSO₄ Reference Electrode – 1.25 inches diameter, 6 inches long with solid copper rod contacting a saturated solution of copper sulfate, with porous plug allowing electrical contact with the soil.
 10. Low Voltage, Wet Sponge Holiday Detector – Portable, battery operated, self-contained unit, with terminal connections for ground wire to the structure, and open cell sponge electrode. Voltage rating shall be between 5 and 90 VDC, providing an audible signal for locating coating faults.

- B. Polyethylene Encasement – Notify the Engineer for inspection of polyethylene encasement installation.
1. After polyethylene encasement installation has been completed, prior to backfilling, a visual inspection of all polyethylene encasement shall be completed.
 2. All punctures and tears shall be repaired to the satisfaction of the Engineer. Piping systems shall not be backfilled until the repairs have been properly installed and verified.
 3. Polyethylene encased piping systems shall be holiday free prior to backfilling.
- C. Exothermic Welds – Test exothermic welds by striking the completed weld with a 2-pound hammer at a 45-degree angle to the pipe surface. If the weld is knocked off or moves at the pipe/weld interface, a new weld connection shall be made.
- D. Electrical Continuity – Test electrically bonded piping prior to and after backfilling between all accessible test points.
1. Test Procedure for Single Bond and Multiple Bonds in Parallel
 - a. Connect instruments across bond as shown on Figure 1. Use separate set of contact points to structures for voltage and current circuits.
 - b. Close switch and observe meter readings. Beginning with the highest scales on voltmeter and ammeter, reduce meter ranges until lowest possible scale is reached, and record ON readings.
 - c. Open circuit and immediately record OFF readings. Obtain a minimum of three ON and three OFF readings.
 - d. Determine incremental change for voltage and current.
 - e. Calculate and record bond resistance for each reading as shown.
 - f. Resistance of bond shall not exceed calculated theoretical resistance by more than 10%.
 2. Test Procedure for Multiple Bonds in Series
 - a. Connect instruments as shown on Figure 2.
 - b. Calculate and record resistance between points A and B, including bonds in series as specified for single bond test.
 - c. Total resistance measured between points A and B shall not exceed the theoretical resistance of the sum of bonds plus theoretical resistance of structure between points A and B by more than 10%.
- E. Insulating Fittings – Test insulating fittings before they are backfilled and again after backfilling.
1. Set up instrumentation as shown on Figure 3. Place reference electrode in contact with the soil adjacent to the fitting if not backfilled, or directly above the buried fitting if backfilled.
 2. Close switch in I1 circuit. Read and record current (I1), and voltage (E1 (c)).
 3. Open switch in I1 circuit. Read and record voltage (E1 (o)).

4. Close switch in I1 circuit. Read and record current (I1), and voltage (E2(c)).
 5. Open switch in I1 circuit. Read and record voltage (E2(o)). The value of E2(c) - E2(o) shall be less than or equal to zero.
- F. Anodes – Test anodes after piping and cathodic protection systems have been completed and backfilled.
1. Structure-to-Anode Resistance Test
 - a. Set up instrumentation as shown on Figure 4.
 - b. Close switch in I1 circuit. Read and record current (I1) and voltage (E1(c))
 - c. Open switch. Read and record voltage (E1(o))
 - d. Repeat and record readings a minimum of three times
 - e. Calculate Structure-to-Anode resistance using formula shown
 2. Anode-to-Earth Resistance Test
 - a. Set up instrumentation as shown on Figure 4.
 - b. Close switch in I1 circuit. Read and record current (I1) and voltage (E2(c))
 - c. Open switch. Read and record voltage (E2(o))
 - d. Repeat and record readings a minimum of three times
 - e. Calculate Anode-to-Earth resistance using formula shown
- G. Reference Electrodes – Follow test procedures used for determining Anode-to-Earth Resistance.
- H. Cathodic Protection Depolarization Test – After completion of testing to verify electrical continuity, structure-to-earth and anode-to-earth resistances, and isolation from unprotected structures, the following test shall be performed to verify adequate cathodic protection has been achieved:
1. Connect all anodes in the system to the structure to be cathodically protected 24 hours prior to performing the following test procedure.
 2. "Zero" the recording voltmeter and allow to run for at least 5 minutes.
 3. Set up instrumentation as shown on Figure 5.
 4. With the switch closed in the I1 circuit, read and record anode output current.
 5. Disconnect all anodes simultaneously by opening the I1 circuit(s).
 6. Allow recorder to run until the cathodic polarization value ("instant off") clearly decays at least 100 millivolts.
 7. Reconnect all anodes and allow recorder to run at least 5 minutes.
 8. Disconnect recorder from test circuit and allow to "zero" for an additional 5 minutes.
 9. Record times, date, scale, chart speed and structure location on the recording chart.

10. If the structure surface potential fails to depolarize the required 100 millivolts, the Contractor shall implement remedial measures, as approved by the Engineer, to achieve adequate cathodic protection of the structure.

FIGURE 1 – SINGLE BOND AND MULTIPLE BONDS IN PARALLEL



FORMULA FOR DETERMINING RESISTANCE OF SINGLE BOND USING TEST DATA:

$$R_T = \Delta E / \Delta i$$

WHERE R_T = RESISTANCE OF ONE BOND (OHM)
 ΔE = INCREMENTAL CHANGE IN POTENTIAL (VOLT)
 Δi = INCREMENTAL CHANGE IN CURRENT (AMPERE)

FORMULA FOR CALCULATING THEORETICAL RESISTANCE OF SINGLE BOND:

$$R_c = (L) \times (R_L)$$

WHERE R_c = CALCULATED RESISTANCE OF ONE BOND (OHM)
 L = LENGTH (METER)
 R_L = RESISTANCE (OHM/METER) FROM WIRE TABLE FOR BOND WIRE USED

FORMULA FOR CALCULATING THEORETICAL RESISTANCE BETWEEN STRUCTURES CONNECTED BY MULTIPLE BONDS IN PARALLEL:

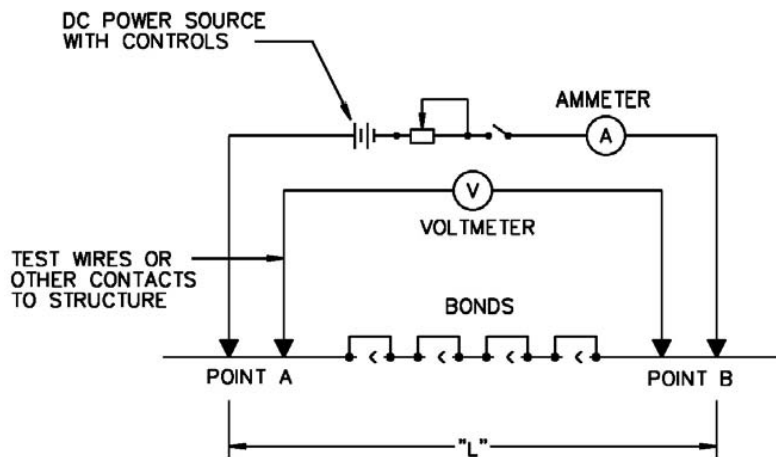
$$R_{cp} = R_c / N$$

WHERE R_{cp} = CALCULATED RESISTANCE OF MULTIPLE BOND WIRE IN PARALLEL (OHM)
 R_c = CALCULATED RESISTANCE OF ONE BOND (OHM)
 N = NUMBER OF BONDS IN PARALLEL

NOTE:

1. VOLTMETER CONTACTS TO STRUCTURE MUST BE CLOSE ENOUGH TO WELDS TO ENSURE THAT STRUCTURE RESISTANCE IS NOT SIGNIFICANT.

FIGURE 2 – MULTIPLE BONDS IN SERIES

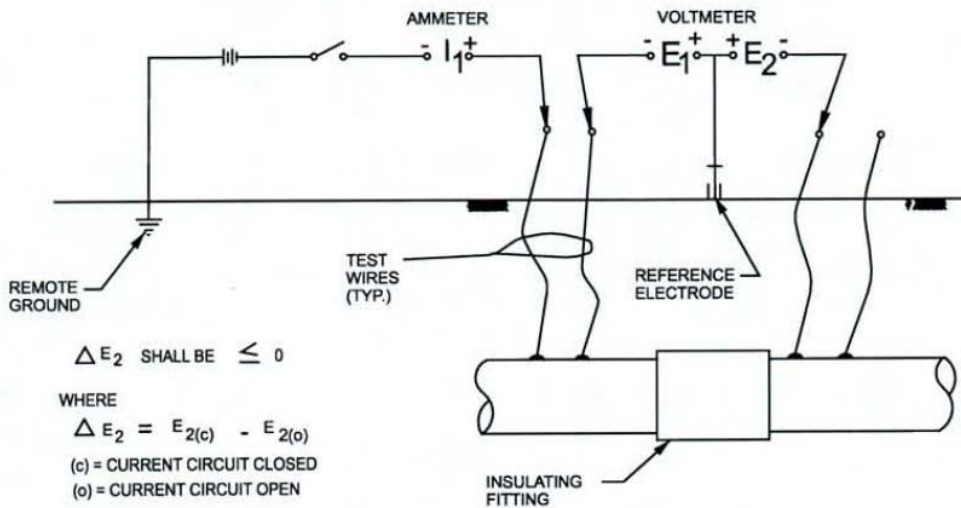


FORMULA FOR CALCULATING THEORETICAL RESISTANCE OF STRUCTURE WITH MULTIPLE BONDS IN SERIES:

$$R_{cs} = R_c \times N \times \rho \frac{L}{A}$$

- WHERE R_{cs} = CALCULATED RESISTANCE OF A NUMBER OF BONDS IN SERIES (OHM)
 R_c = CALCULATED RESISTANCE OF ONE BOND (OHM)
 N = NUMBER OF BONDS IN SERIES
 ρ = RESISTIVITY OF STRUCTURE (OHM-cm)
 L = LENGTH OF STRUCTURE (cm)
 A = CROSS SECTIONAL AREA OF STRUCTURE (cm)²

FIGURE 3 – INSULATING FITTINGS



$$\Delta E_2 \text{ SHALL BE } \leq 0$$

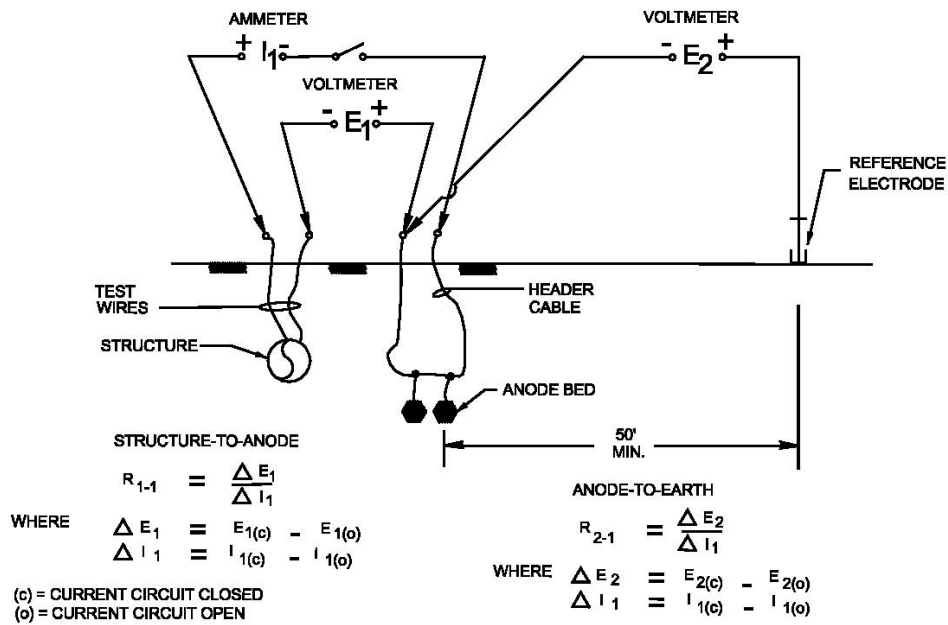
WHERE

$$\Delta E_2 = E_{2(c)} - E_{2(o)}$$

- (c) = CURRENT CIRCUIT CLOSED
(o) = CURRENT CIRCUIT OPEN

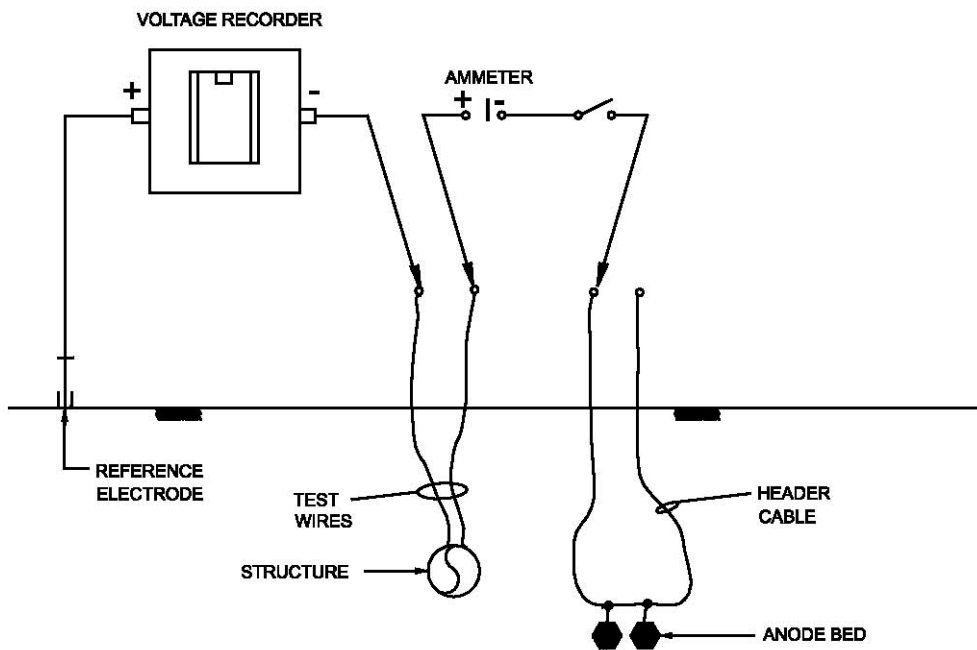
BURIED INSULATING FITTING TEST

FIGURE 4 – RESISTANCE TESTS



STRUCTURE-TO-ANODE AND ANODE-TO-EARTH RESISTANCE TESTS

FIGURE 5 – CATHODIC PROTECTION DEPOLARIZATION TEST



CATHODIC PROTECTION DEPOLARIZATION TEST

PART 4 - MEASUREMENT AND PAYMENT**4.1 MEASUREMENT**

A. The quantities of accepted work will be measured in the following units. All measurements will be plan measure except for authorized changes.

1. Description: Lump Sum

4.2 PAYMENT

1. Payment will be made at the respective unit or lump-sum price listed in the proposal and shall be full compensation for all labor, materials, and equipment necessary to complete the respective unit in place. There will be no separate measurement or payment for any item of work not specifically identified and listed in the proposal, and all such work shall be considered a subsidiary item with all costs pertaining thereto included in the prices for other items listed in the proposal. At the Engineer's option, partial payment may be made for any lump sum item listed in the proposal, providing that the Contractor is diligently and satisfactorily pursuing full completion of such partially complete item in accordance with the approved job progress schedule.

END OF SECTION

SECTION 26 43 13**TRANSIENT-VOLTAGE SUPPRESSION FOR PANELBOARDS**

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section includes TVSS for panelboards.

1.03 DEFINITIONS

- A. ATS: Acceptance Testing Specifications.
- B. SVR: Suppressed voltage rating.
- C. TVSS: Transient voltage surge suppressor(s), both singular and plural; also, transient voltage surge suppression.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating weights, electrical characteristics, furnished specialties, and accessories.

1.05 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified testing agency.
- B. Product Certificates: For TVSS devices, from manufacturer.
- C. Field quality-control reports.
- D. Warranties: Sample of special warranties.

1.06 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For TVSS devices to include in emergency, operation, and maintenance manuals.

1.07 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Replaceable Protection Modules: One of each size and type installed.

1.08 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a testing agency, and marked for intended location and application.
- B. Comply with IEEE C62.41.2 and test devices according to IEEE C62.45.
- C. Comply with NEMA LS 1.
- D. Comply with UL 1283 and UL 1449 3rd Edition.
- E. Comply with NFPA 70.

1.09 PROJECT CONDITIONS

- A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by City or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:
 - 1. Notify Owner no fewer than seven days in advance of proposed electrical service interruptions.
 - 2. Do not proceed with interruption of electrical service without Owner's written permission.
- B. Service Conditions: Rate TVSS devices for continuous operation under the following conditions unless otherwise indicated:
 - 1. Maximum Continuous Operating Voltage: Not less than 115 percent of nominal system operating voltage.
 - 2. Operating Temperature: 30 to 120 deg F.
 - 3. Humidity: 0 to 85 percent, noncondensing.
 - 4. Altitude: Less than 20,000 feet above sea level.

1.10 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of surge suppressors that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS**2.01 PANELBOARD TVSS**

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. ABB USA.
 2. AC Data Solutions.
 3. Advanced Protection Technologies Inc. (APT).
 4. Atlantic Scientific.
 5. Current Technology Inc.; Danaher Power Solutions.
 6. Danaher Power Solutions; United Power Products.
 7. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 8. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 9. Intermatic, Inc.
 10. LEA International.
 11. Leviton Mfg. Company Inc.
 12. Liebert Corporation; a division of Emerson Network Power.
 13. Northern Technologies, Inc.; a division of Emerson Network Power.
 14. Siemens Energy & Automation, Inc.
 15. Square D; a brand of Schneider Electric.
 16. Surge Suppression Incorporated.
- B. Surge Protection Devices:
1. Comply with UL 1449, 3rd Edition.
 2. Modular design (with field-replaceable modules).
 3. Fuses, rated at 200-kA interrupting capacity.
 4. Fabrication using bolted compression lugs for internal wiring.
 5. Integral disconnect switch.
 6. Redundant suppression circuits.
 7. Redundant replaceable modules.
 8. Arrangement with copper bus bars and for bolted connections to phase buses, neutral bus, and ground bus.
 9. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
 10. LED indicator lights for power and protection status.
 11. Audible alarm, with silencing switch, to indicate when protection has failed.
 12. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of protection status. Contacts shall reverse on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
 13. Four-digit transient-event counter set to totalize transient surges.
- C. Peak Single-Impulse Surge Current Rating: 320 kA per mode/640 kA per phase.
- D. Minimum single impulse current ratings, using 8-by-20-mic.sec waveform described in IEEE C62.41.2
1. Line to Neutral: 70,000 A.
 2. Line to Ground: 70,000 A.

3. Neutral to Ground: 50,000 A.
- E. Protection modes and UL 1449 SVR for grounded wye circuits with 3-phase, 4-wire circuits shall be as follows:
1. Line to Neutral: 800V for 480V and 400 V for 208V.
 2. Line to Ground: 800V for 480V and 400 V for 208V.
 3. Neutral to Ground: 800V for 480V and 400 V for 208V.
- F. Protection modes and UL 1449 SVR for 240 V, 480 V, or 600 V, 3-phase, 3-wire, delta circuits shall be as follows:
1. Line to Line: 1000 V for 240 V.
 2. Line to Ground: 1000 V for 240 V.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. TVSS shall be factory installed.

3.02 FIELD QUALITY CONTROL

- A. Tests and Inspections:
1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS, "Surge Arresters, Low-Voltage Surge Protection Devices" Section. Certify compliance with test parameters.
 2. After installing TVSS devices but before electrical circuitry has been energized, test for compliance with requirements.
 3. Complete startup checks according to manufacturer's written instructions.
- B. TVSS device will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

3.03 STARTUP SERVICE

- A. Do not perform insulation resistance tests of the distribution wiring equipment with the TVSS installed. Disconnect before conducting insulation resistance tests, and reconnect immediately after the testing is over.

3.04 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to maintain TVSS devices.

END OF SECTION 26 43 13

SECTION 26 51 00
INTERIOR LIGHTING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Interior lighting fixtures, lamps, and ballasts.
2. Exit signs.
3. Lighting fixture supports.

B. Related Sections:

1. Division 26 Section "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, and finishes.

B. Shop Drawings: Show details of nonstandard or custom lighting fixtures. Indicate dimensions, weights, methods of field assembly, components, features, and accessories. **Product Certificates:** For each type of ballast for bi-level and dimmer-controlled fixtures, from manufacturer.

C. Low Mercury Lamps: Low mercury lamps are required for this project. Mercury content shall be less than 90 picograms per lumen-hour. Contractor shall submit manufacturers data for each lamp indicating mercury content is less than 90 picograms per lumen-hour.

1.03 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.04 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NFPA 70.

PART 2 - PRODUCTS**2.01 MANUFACTURERS**

- A. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, product(s) indicated on Drawings.

2.02 GENERAL REQUIREMENTS FOR LIGHTING FIXTURES AND COMPONENTS

- A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.
- B. HID Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5B.
- C. Metal Parts: Free of burrs and sharp corners and edges.
- D. Sheet Metal Components: Steel unless otherwise indicated. Form and support to prevent warping and sagging.
- E. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.
- F. Diffusers and Globes:
 - 1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
 - a. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.
 - b. UV stabilized.
 - 2. Glass: Annealed crystal glass unless otherwise indicated.

2.03 LED LIGHT FIXTURES

- A. Mercury content shall be less than 90 picograms per lumen-hour. Refer to plans for additional LED light fixture requirements.

2.04 EXIT SIGNS

- A. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.
- B. Internally Lighted Signs:
 - 1. Lamps for AC Operation: Fluorescent, two for each fixture, 20,000 hours of rated lamp life.

2. Lamps for AC Operation: LEDs, 50,000 hours minimum rated lamp life.
3. Mercury content shall be less than 90 picograms per lumen-hour.

2.05 LIGHTING FIXTURE SUPPORT COMPONENTS

- A. Comply with Division 26 Section "Hangers and Supports for Electrical Systems" for channel- and angle-iron supports and nonmetallic channel and angle supports.
- B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.
- C. Twin-Stem Hangers: Two, 1/2-inch steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.
- D. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage.
- E. Wires for Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 12 gage.
- F. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.
- G. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Lighting fixtures: Set level, plumb, and square with ceilings and walls. Install lamps in each fixture.
- B. Comply with NFPA 70 for minimum fixture supports.
- C. Suspended Lighting Fixture Support:
 1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
 2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.
 3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.
- D. Adjust aimable lighting fixtures to provide required light intensities.
- E. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.02 FIELD QUALITY CONTROL

- A. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

END OF SECTION 26 51 00

SECTION 26 56 00
EXTERIOR LIGHTING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
1. Exterior luminaires with lamps and ballasts.
 2. LED lighting
 3. Poles and accessories.

1.02 ACTION SUBMITTALS

- A. Product Data: For each luminaire, pole, and support component, arranged in order of lighting unit designation. Include data on features, accessories, and finishes.
- B. Shop Drawings: Anchor-bolt templates keyed to specific poles and certified by manufacturer.

1.03 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with IEEE C2, "National Electrical Safety Code."
- C. Comply with NFPA 70.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, product(s) indicated on Drawings.

2.02 GENERAL REQUIREMENTS FOR LUMINAIRES

- A. Luminaires shall comply with UL 1598 and be listed and labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.

1. LED fixtures shall meet latest applicable testing standards.
- B. Lateral Light Distribution Patterns: Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.
- C. Metal Parts: Free of burrs and sharp corners and edges.
- D. Sheet Metal Components: Corrosion-resistant aluminum unless otherwise indicated. Form and support to prevent warping and sagging.
- E. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.
- F. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses. Designed to disconnect ballast when door opens.
- G. Exposed Hardware Material: Stainless steel.
- H. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
- I. Light Shields: Factory installed arranged to block light distribution to indicated portion of normally illuminated area or field.
- J. Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.
- K. Luminaire Finish: Manufacturer's paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.

2.03 BALLASTS FOR HID LAMPS

- A. Electronic Ballast for Metal-Halide Lamps: Include the following features unless otherwise indicated:
 1. Minimum Starting Temperature: Minus 20 deg F for single-lamp ballasts.
 2. Rated Ambient Operating Temperature: 130 deg F.
 3. Lamp end-of-life detection and shutdown circuit.
 4. Sound Rating: Class A.
 5. Total Harmonic Distortion Rating: Less than 20 percent.
 6. Transient Voltage Protection: IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
 7. Lamp Current Crest Factor: 1.5 or less.
 8. Power Factor: 0.90 or higher.
 9. Interference: Comply with 47 CFR 18, Ch. 1, Subpart C, for limitations on electromagnetic and radio-frequency interference for nonconsumer equipment.

10. Protection: Class P thermal cutout.

2.04 HID LAMPS

- A. Metal-Halide Lamps: ANSI C78.43, with minimum CRI 65, and color temperature 4000 K. Mercury content shall be less than 90 picograms per lumen-hour.
- B. Pulse-Start, Metal-Halide Lamps: Minimum CRI 65, and color temperature 4000 K. Mercury content shall be less than 90 picograms per lumen-hour.

2.05 GENERAL REQUIREMENTS FOR POLES AND SUPPORT COMPONENTS

- A. Structural Characteristics: Comply with AASHTO LTS-4-M.

2.06 LED Light Fixtures

- A. UL listed and ARRA compliant. Include the following features unless otherwise indicated:
 - 1. LED color temperature 4,000 K.
 - 2. Entire fixture and LED system 50,000 hour rated.
 - 3. Full cutoff. No lumens above 90 degrees.
 - 4. Minimum Starting Temperature: Minus 22 deg F (Minus 30 deg C).
 - 5. Normal Ambient Operating Temperature: 104 deg F (40 deg C).

PART 3 - EXECUTION

3.01 LUMINAIRE INSTALLATION

- A. Install lamps in each luminaire.
- B. Fasten luminaire to indicated structural supports.
 - 1. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.
- C. Adjust luminaires that require field adjustment or aiming.

3.02 POLE INSTALLATION

- A. Alignment: Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on the pole.
- B. Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features unless otherwise indicated on Drawings:

1. Fire Hydrants and Storm Drainage Piping: 60 inches (1520 mm).
 2. Water, Gas, Electric, Communication, and Sewer Lines: 10 feet (3 m).
 3. Trees: 15 feet (5 m) from tree trunk.
- C. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified in KCMO APWA.
- D. Foundation-Mounted Poles: Mount pole with leveling nuts, and tighten top nuts to torque level recommended by pole manufacturer.
1. Use anchor bolts and nuts selected to resist seismic forces defined for the application and approved by manufacturer.
 2. Grout void between pole base and foundation. Use nonshrink or expanding concrete grout firmly packed to fill space.
 3. Install base covers unless otherwise indicated.
 4. Use a short piece of 1/2-inch- (13-mm-) diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.

3.03 CORROSION PREVENTION

- A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.
- B. Steel Conduits: Comply with Section 26 05 33 "Raceways and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch- (0.254-mm-) thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.04 GROUNDING

- A. Ground metal poles and support structures according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."
1. Install grounding electrode for each pole unless otherwise indicated.
 2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.
- B. Ground nonmetallic poles and support structures according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."
1. Install grounding electrode for each pole.
 2. Install grounding conductor and conductor protector.
 3. Ground metallic components of pole accessories and foundations.

SCHEDULE 1 - FIELD QUALITY CONTROL

- A. Inspect each installed fixture for damage. Replace damaged fixtures and components.

- B. Illumination Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source.
 - 1. Verify operation of photoelectric controls.
- C. Illumination Tests:
 - 1. Measure light intensities at night. Use photometers with calibration referenced to NIST standards. Comply with the following IESNA testing guide(s):
 - a. IESNA LM-64, "Photometric Measurements of Parking Areas."
 - b. IESNA LM-72, "Directional Positioning of Photometric Data."
- D. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

END OF SECTION 26 56 00

SECTION 26 56 10
STATION STOP LIGHTING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
1. Exterior luminaires with lamps and ballasts.
 2. LED lighting

1.02 ACTION SUBMITTALS

- A. Product Data: For each luminaire, pole, and support component, arranged in order of lighting unit designation. Include data on features, accessories, and finishes.

1.03 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with IEEE C2, "National Electrical Safety Code."
- C. Comply with NFPA 70.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, product(s) indicated on Drawings.

2.02 GENERAL REQUIREMENTS FOR LUMINAIRES

- A. Luminaires shall comply with UL 1598 and be listed and labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.
1. LED fixtures shall meet latest applicable testing standards.
- B. Lateral Light Distribution Patterns: Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.

- C. Metal Parts: Free of burrs and sharp corners and edges.
- D. Sheet Metal Components: Corrosion-resistant aluminum unless otherwise indicated. Form and support to prevent warping and sagging.
- E. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.
- F. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses. Designed to disconnect ballast when door opens.
- G. Exposed Hardware Material: Stainless steel.
- H. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
- I. Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.
- J. Luminaire Finish: Manufacturer's paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.

2.03 GENERAL REQUIREMENTS FOR POLES AND SUPPORT COMPONENTS

- A. Structural Characteristics: Comply with AASHTO LTS-4-M.

2.04 LED Light Fixtures

- A. UL listed and ARRA compliant. Include the following features unless otherwise indicated:
 - 1. Entire fixture and LED system 50,000 hour rated.

PART 3 - EXECUTION

3.01 LUMINAIRE INSTALLATION

- A. Install lamps in each luminaire.
- B. Fasten luminaire to indicated structural supports.

1. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.
- C. Adjust luminaires that require field adjustment or aiming.

3.02 CORROSION PREVENTION

- A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.
- B. Steel Conduits: Comply with Section 26 05 33 "Raceways and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch- (0.254-mm-) thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.03 GROUNDING

- A. Ground fixtures and support structures according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."
1. Install grounding electrode for each fixture unless otherwise indicated.

SCHEDULE 1 - FIELD QUALITY CONTROL

- A. Inspect each installed fixture for damage. Replace damaged fixtures and components.
- B. Illumination Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source.
1. Verify operation of photoelectric controls.
- C. Illumination Tests:
1. Measure light intensities at night. Use photometers with calibration referenced to NIST standards. Comply with the following IESNA testing guide(s):
 - a. IESNA LM-64, "Photometric Measurements of Parking Areas."
 - b. IESNA LM-72, "Directional Positioning of Photometric Data."
- D. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

PART IV - MEASUREMENT

4.1 Measurement – No Separate measurement will be made for Work described in this Section.

PART V - PAYMENT

5.1 Payment – Payment for items in this Section will be incidental to the Contract lump sum unit cost of the Station Stops.

END OF SECTION 26 56 10

SECTION 27 51 23**INTERCOMMUNICATIONS AND PROGRAM SYSTEMS**

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Manually switched intercommunications and program systems with the following components:
 - 1. Paging controller
 - 2. Paging amplifier.
 - 3. Loudspeakers/speaker microphones.
 - 4. Conductors and cables.
 - 5. Raceways.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For intercommunications and program systems. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Wiring Diagrams: For power, signal, and control wiring.
 - a. Identify terminals to facilitate installation, operation, and maintenance.
 - b. Single-line diagram showing interconnection of components.
 - c. Cabling diagram showing cable routing and conduit.
 - 2. Sound Level Plans: Submit plans indicating sound levels in dBA on 10 ft spacings at 5 ft above floor level in all areas.

1.03 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.04 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.05 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with NFPA 70.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

PART 3 - See Editing Instruction No.1 in the Evaluations for cautions about naming manufacturers. Retain paragraph and list of manufacturers below. See Section 01 60 00 "Product Requirements."

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Aiphone Corporation.
 - 2. Alpha Communications.
 - 3. Bogen Communications, Inc.
 - 4. Dukane Communication Systems; part of GE Infrastructure, Security.
 - 5. Federal Signal Corporation; Electrical Products Division.
 - 6. Jeron Electronic Systems, Inc.
 - 7. Rauland-Borg Corporation.
 - 8. TOA Electronics, Inc.
 - 9. Valcom, Inc
 - 10. Zenitel USA; the home of STENTOFON brand products.

3.02 FUNCTIONAL DESCRIPTION OF SYSTEMS

- A. Microphone Station:
 - 1. Provide controller and amplifier to connect to telephone board. Telephones shall be utilized for announcements.
- B. Speakers: Free of noise and distortion during operation and when in standby mode.

3.03 GENERAL REQUIREMENTS FOR EQUIPMENT AND MATERIALS

- A. Coordinate features and select components to form an integrated system. Match components and interconnections for optimum performance of specified functions.
- B. Equipment: Modular type using solid-state components, fully rated for continuous duty unless otherwise indicated. Select equipment for normal operation on input power usually supplied at 110 to 130 V, 60 Hz.

- C. Weather-Resistant Equipment: Listed and labeled by an NRTL for duty outdoors or in wet locations as indicated on the plans.

3.04 PAGING CONTROLLER

- A. Three zones, all call, background music input, integrated single/warble tone generators, programmable per zone.

3.05 SPEAKER STATIONS

- A. Mounting: Flush unless otherwise indicated, and suitable for mounting conditions indicated.
- B. Faceplate: Tamperproof mounting screws.
- C. Back Box: Two-gang galvanized steel with 2-1/2-inch (64-mm) minimum depth.
- D. Speaker: permanent magnet.
- E. Tone Annunciation: Recurring momentary tone indicates incoming calls.

3.06 PAGING AMPLIFIER

- A. Input Voltage: 120-V ac, 60 Hz.
- B. Frequency Response: Within plus or minus 3 dB from 60 to 10,000 Hz.
- C. Minimum Signal-to-Noise Ratio: 60 dB, at rated output.
- D. Total Harmonic Distortion: Less than 3 percent at rated power output from 70 to 12,000 Hz.
- E. Output Regulation: Less than 2 dB from full to no load.
- F. Controls: On-off, input levels, and low-cut filter.
- G. Input Sensitivity: Matched to input circuit and to provide full-rated output with sound-pressure level of less than 10 dynes/sq. cm impinging on speaker microphones or handset transmitters.
- H. Amplifier Protection: Prevents damage from shorted or open output.
- I. Output Circuit: 70-V line.
- J. Power output suitable to provide system requirements.

3.07 CONE-TYPE LOUDSPEAKERS

- A. Minimum Axial Sensitivity: 91 dB at one meter, with 1-W input.
- B. Frequency Response: Within plus or minus 3 dB from 70 to 15,000 Hz.
- C. Minimum Dispersion Angle: 100 degrees.
- D. Line Transformer: Maximum insertion loss of 0.5 dB, power rating equal to speaker's, and at least four level taps.
- E. Enclosures: Steel housings or back boxes, acoustically dampened, with front face of steel and whole assembly rust proofed and factory primed; complete with mounting assembly and suitable for surface ceiling, flush ceiling, pendant or wall mounting; with relief of back pressure.

3.08 HORN-TYPE LOUDSPEAKERS

- A. Speakers shall be weatherproof, -4 deg F to 131 deg F rated construction; complete with universal mounting brackets.
- B. Frequency Response: Within plus or minus 3 dB from 275 to 14,000 Hz.
- C. Minimum Power Rating of Driver: 15 W, continuous.
- D. Minimum Dispersion Angle: 110 degrees.
- E. Line Transformer: Maximum insertion loss of 0.5 dB, power rating equal to speaker's, and at least four level taps.

3.09 CONDUCTORS AND CABLES

- A. Conductors: Jacketed, twisted pair and twisted multipair, untinned solid copper. Sizes as recommended by system manufacturer, but no smaller than No. 22 AWG.
- B. Insulation: Thermoplastic, not less than 1/32 inch (0.8 mm) thick.
- C. Shielding: For speaker-microphone leads and elsewhere where recommended by manufacturer; No. 34 AWG, tinned, soft-copper strands formed into a braid or equivalent foil.
 - 1. Minimum Shielding Coverage on Conductors: 60 percent.
- D. Plenum Cable: Listed and labeled for plenum installation.

3.10 RACEWAYS

- A. Intercommunication and Program System Raceways and Boxes: Comply with requirements in Section 26 05 33 "Raceway and Boxes for Electrical Systems."

- B. Outlet boxes shall be not less than 2 inches (50 mm) wide, 3 inches (75 mm) high, and 2-1/2 inches (64 mm) deep.
- C. Flexible metal conduit is prohibited.

PART 4 - EXECUTION

4.01 WIRING METHODS

- A. Wiring Method In Exposed Locations: Install cables in raceways and except within consoles, cabinets, desks, and counters. Conceal raceway and cables except in unfinished spaces.
 - 1. Install plenum cable in environmental air spaces, including plenum ceilings.
 - 2. Comply with requirements for raceways and boxes specified in Section 26 05 33 "Raceway and Boxes for Electrical Systems."
- B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
- C. Wiring within Enclosures: Bundle, lace, and train cables to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

4.02 INSTALLATION OF RACEWAYS

- A. Comply with requirements in Section 26 05 33 "Raceway and Boxes for Electrical Systems" for installation of conduits and wireways.
- B. Install manufactured conduit sweeps and long-radius elbows whenever possible.

4.03 INSTALLATION OF CABLES

- A. Comply with NECA 1.
- B. General Requirements:
 - 1. Terminate conductors; no cable shall contain unterminated elements. Make terminations only at outlets and terminals.
 - 2. Splices, Taps, and Terminations: Arrange on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures. Cables may not be spliced.
 - 3. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
 - 4. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

5. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
 6. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used.
- C. Open-Cable Installation:
1. Install cabling with horizontal and vertical cable guides in telecommunication spaces with terminating hardware and interconnection equipment.
 2. Suspend speaker cable not in a wireway or pathway a minimum of 8 inches (200 mm) above ceiling by cable supports not more than 60 inches (1524 mm) apart.
 3. Cable shall not be run through structural members or be in contact with pipes, ducts, or other potentially damaging items.
- D. Separation of Wires: Separate speaker-microphone, line-level, speaker-level, and power wiring runs. Install in separate raceways or, where exposed or in same enclosure, separate conductors at least 12 inches (300 mm) apart for speaker microphones and adjacent parallel power and telephone wiring. Separate other intercommunication equipment conductors as recommended by equipment manufacturer.

4.04 INSTALLATION

- A. Match input and output impedances and signal levels at signal interfaces. Provide matching networks where required.
- B. Identification of Conductors and Cables: Color-code conductors and apply wire and cable marking tape to designate wires and cables so they identify media in coordination with system wiring diagrams.
- C. Weatherproof Equipment: For units that are mounted outdoors, in damp locations, or where exposed to weather, install consistent with requirements of weatherproof rating.
- D. Speaker-Line Matching Transformer Connections: Make initial connections using tap settings indicated on Drawings.
- E. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

4.05 GROUNDING

- A. Ground cable shields and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.
- B. Signal Ground Terminal: Locate at main equipment cabinet. Isolate from power system and equipment grounding.
- C. Install grounding electrodes as specified in Section 26 05 26 "Grounding and Bonding for Electrical Systems."

4.06 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections:
 - 1. Schedule tests with at least seven days' advance notice of test performance.
 - 2. After installing intercommunications and program systems and after electrical circuitry has been energized, test for compliance with requirements.
 - 3. Operational Test: Test originating messages at each phone station. Verify proper routing and volume levels and that system is free of noise and distortion. Test each available message path from each station on system.
- C. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified. Prepare a list of final tap settings of paging speaker-line matching transformers.
- D. Intercommunications and program systems will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports.

END OF SECTION 27 51 23

SECTION 28 05 13**CONDUCTORS AND CABLES FOR ELECTRONIC SAFETY AND SECURITY****PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Fire alarm wire and cable.
 - 2. Identification products.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified layout technician, installation supervisor, and field inspector.
- B. Source quality-control reports.
- C. Field quality-control reports.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Inspect cables upon receipt at Project site.

1.6 FIELD CONDITIONS

- A. Do not install conductors and cables that are wet, moisture damaged, or mold damaged.
 - 1. Indications that wire and cables are wet or moisture damaged include, but are not limited to, discoloration and sagging of factory packing materials.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame-Spread Index: 25 or less.
 - 2. Smoke-Developed Index: 450 or less.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 BACKBOARDS

- A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches (19 by 1220 by 2440 mm). Comply with requirements for plywood backing panels in Section 06 10 00 "Rough Carpentry."

2.3 FIRE ALARM WIRE AND CABLE

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Comtran Corporation.
 - 2. Draka Cableteq USA.
 - 3. Genesis Cable Products; Honeywell International, Inc.
 - 4. Rockbestos-Suprenant Cable Corp.
 - 5. West Penn Wire.
- B. General Wire and Cable Requirements: NRTL listed and labeled as complying with NFPA 70, Article 760.
- C. Signaling Line Circuits: Twisted, shielded pair, No. 16 AWG.
 - 1. Circuit Integrity Cable: Twisted shielded pair, NFPA 70, Article 760, Classification CI, for power-limited fire alarm signal service Type FPL. NRTL listed and labeled as complying with UL 1424 and UL 2196 for a 2-hour rating.
- D. Non-Power-Limited Circuits: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation.
 - 1. Low-Voltage Circuits: No. 16 AWG, minimum.
 - 2. Line-Voltage Circuits: No. 12 AWG, minimum.
 - 3. Multiconductor Armored Cable: NFPA 70, Type MC, copper conductors, Type TFN/THHN conductor insulation, copper drain wire, copper armor with outer jacket with red identifier stripe, NRTL listed for fire alarm and cable tray

installation, plenum rated, and complying with requirements in UL 2196 for a 2-hour rating.

2.4 IDENTIFICATION PRODUCTS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Brady Worldwide, Inc.
 - 2. HellermannTyton North America.
 - 3. Kroy LLC.
 - 4. Panduit Corp.
- B. Comply with UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.
- C. Comply with requirements in Section 26 05 53 "Identification for Electrical Systems."

PART 3 - EXECUTION

3.1 INSTALLATION OF HANGERS AND SUPPORTS

- A. Comply with requirements in Section 26 05 29 "Hangers and Supports for Electrical Systems" for installation of supports for cables.

3.2 WIRING METHOD

- A. Install wiring in metal pathways and wireways FOR EXPOSED AREAS.
 - 1. Minimum conduit size shall be 1/2 inch. Control and data transmission wiring shall not share conduit with other building wiring systems.
 - 2. Comply with requirements in Section 26 05 33 "Raceways and Boxes for Electrical Systems."
- B. Install cable, concealed in accessible ceilings, walls, and floors when possible.
- C. Wiring within Enclosures:
 - 1. Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.
 - 2. Install lacing bars and distribution spools.
 - 3. Separate power-limited and non-power-limited conductors as recommended in writing by manufacturer.
 - 4. Install conductors parallel with or at right angles to sides and back of enclosure.
 - 5. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with intrusion system to terminal blocks.
 - 6. Mark each terminal according to system's wiring diagrams.

7. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

3.3 FIRE ALARM WIRING INSTALLATION

- A. Comply with NECA 1 and NFPA 72.
- B. Wiring Method Exposed Indoor & Outdoor Locations: Install wiring in dedicated metal raceway according to Section 26 05 33 "Raceways and Boxes for Electrical Systems."
- C. Wiring Method Concealed Indoor Locations:
 1. Install plenum cable in environmental air spaces, including plenum ceilings.
 2. Fire-Rated Cables: 2-hour, fire-rated fire alarm cables, NFPA 70, Types MI and CI.
- D. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal according to the system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.
- E. Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes, cabinets, or equipment enclosures where circuit connections are made.
- F. Color-Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and another for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire alarm system junction boxes and covers red.
- G. Risers: Install at least two vertical cable risers to serve the fire alarm system. Separate risers in close proximity to each other with a minimum one-hour-rated wall, so the loss of one riser does not prevent the receipt or transmission of signals from other floors or zones.
- H. Wiring to Remote Alarm Transmitting Device: 1-inch (25-mm) conduit between the fire alarm control panel and the transmitter. Install number of conductors and electrical supervision for connecting wiring as needed to suit monitoring function.

3.4 POWER AND CONTROL-CIRCUIT CONDUCTORS

- A. 120-V Power Wiring: Install according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables" unless otherwise indicated.
- B. Minimum Conductor Sizes:
 1. Class 1 remote-control and signal circuits, No. 14 AWG.

2. Class 2 low-energy, remote-control and signal circuits, No. 16 AWG.
3. Class 3 low-energy, remote-control, alarm and signal circuits, No. 12 AWG.

3.5 CONNECTIONS

- A. Comply with requirements in Section 28 31 11 "Digital, Addressable Fire-Alarm System for connecting, terminating, and identifying wires and cables.

3.6 FIRESTOPPING

- A. Comply with requirements in Section 07 84 13 "Penetration Firestopping."
- B. Comply with TIA-569-B, "Firestopping" Annex A.
- C. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.7 GROUNDING

- A. For low-voltage wiring and cabling, comply with requirements in Section 26 05 26 "Grounding and Bonding for Electrical Systems."

3.8 IDENTIFICATION

- A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

3.9 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 1. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
- B. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide, or transfer the data from the instrument to the computer, save as text files, print, and submit.
- C. End-to-end cabling will be considered defective if it does not pass inspections.
- D. Prepare inspection reports.

END OF SECTION 28 05 13

SECTION 28 31 11**DIGITAL, ADDRESSABLE FIRE-ALARM SYSTEM**

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fire-alarm control unit.
2. Manual fire-alarm boxes.
3. System smoke detectors.
4. Heat detectors.
5. Notification appliances.
6. Remote annunciator.
7. Addressable interface device.
8. Digital alarm communicator transmitter.

B. Related Requirements:

1. Section 28 05 13 "Conductors and Cables for Electronic Safety and Security" for cables and conductors for fire-alarm systems.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product, including furnished options and accessories.

B. Shop Drawings: For fire-alarm system.

1. Comply with recommendations and requirements in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
2. Include plans, elevations, sections, details, and attachments to other work.
3. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and locations. Indicate conductor sizes, indicate termination locations and requirements, and distinguish between factory and field wiring.
4. Detail assembly and support requirements.
5. Include voltage drop calculations for notification-appliance circuits.
6. Include battery-size calculations.
7. Include input/output matrix.
8. Include statement from manufacturer that all equipment and components have been tested as a system and meet all requirements in this Specification and in NFPA 72.
9. Include performance parameters and installation details for each detector.
10. Verify that each duct detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.

11. Include plans, sections, and elevations of heating, ventilating, and air-conditioning ducts, drawn to scale; coordinate location of duct smoke detectors and access to them.
 - a. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators.
 - b. Show field wiring required for HVAC unit shutdown on alarm.
 - c. Locate detectors according to manufacturer's written recommendations.
12. Include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits and point-to-point wiring diagrams.

C. General Submittal Requirements:

1. Shop Drawings shall be prepared by persons with the following qualifications:
 - a. Trained and certified by manufacturer in fire-alarm system design.
 - b. NICET-certified, fire-alarm technician; Level IV minimum.
 - c. Licensed or certified by authorities having jurisdiction.

D. Delegated-Design Submittal: For notification appliances and smoke and heat detectors, in addition to submittals listed above, indicate compliance with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Drawings showing the location of each notification appliance and smoke and heat detector, ratings of each, and installation details as needed to comply with listing conditions of the device.
2. Design Calculations: Calculate requirements for selecting the spacing and sensitivity of detection, complying with NFPA 72. Calculate spacing and intensities for strobe signals and sound-pressure levels for audible appliances.
3. Indicate audible appliances required to produce square wave signal per NFPA 72.

1.3 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Field quality-control reports.
- C. Sample warranty.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 01 78 23 "Operation and Maintenance Data," include the following:
 - a. Comply with the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
 - b. Provide "Fire Alarm and Emergency Communications System Record of Completion Documents" according to the "Completion Documents" Article in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
 - c. Complete wiring diagrams showing connections between all devices and equipment.
 - d. Riser diagram.
 - e. Record copy of site-specific software.
 - f. Provide "Inspection and Testing Form" according to the "Inspection, Testing and Maintenance" chapter in NFPA 72, and include the following:
 - 1) Equipment tested.
 - 2) Frequency of testing of installed components.
 - 3) Frequency of inspection of installed components.
 - 4) Requirements and recommendations related to results of maintenance.
 - 5) Manufacturer's user training manuals.
 - g. Manufacturer's required maintenance related to system warranty requirements.
 - h. Abbreviated operating instructions for mounting at fire-alarm control unit and each annunciator unit.

B. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On magnetic media or compact disk, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Installation shall be by personnel certified by NICET as fire-alarm Level IV technician.
- B. NFPA Certification: Obtain certification according to NFPA 72 by a UL-listed alarm company.

1.6 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace fire-alarm system equipment and components that fail in materials or workmanship within specified warranty period.

1. Warranty Extent: All equipment and components not covered in the Maintenance Service Agreement.
2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Noncoded, UL-certified addressable system, with multiplexed signal transmission and horn/strobe evacuation.
- B. Automatic sensitivity control of certain smoke detectors.
- C. All components provided shall be listed for use with the selected system.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 SYSTEMS OPERATIONAL DESCRIPTION

- A. Fire-alarm signal initiation shall be by one or more of the following devices:
 1. Manual stations.
 2. Heat detectors.
 3. Smoke detectors.
 4. Duct smoke detectors.
 5. Automatic sprinkler system water flow.
 6. Fire-extinguishing system operation.
- B. Fire-alarm signal shall initiate the following actions:
 1. Continuously operate alarm notification appliances.
 2. Identify alarm and specific initiating device at fire-alarm control unit and remote annunciators.
 3. Transmit an alarm signal to the remote alarm receiving station.
 4. Unlock electric door locks in designated egress paths.
 5. Switch heating, ventilating, and air-conditioning equipment controls to fire-alarm mode.
 6. Activate preaction system.
 7. Recall elevator to primary or alternate recall floors.
 8. Activate elevator power shunt trip.
 9. Activate emergency lighting control.
 10. Activate emergency shutoffs for gas and fuel supplies.
 11. Transmit an alarm signal to the Traction Power Sub-Station (TPSS).
 12. Record events in the system memory.

- C. Supervisory signal initiation shall be by one or more of the following devices and actions:
1. Valve supervisory switch.
 2. Elevator shunt-trip supervision.
 3. Loss of communication with any panel on the network.
- D. System trouble signal initiation shall be by one or more of the following devices and actions:
1. Open circuits, shorts, and grounds in designated circuits.
 2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
 3. Loss of communication with any addressable sensor, input module, relay, control module, or remote annunciator.
 4. Loss of primary power at fire-alarm control unit.
 5. Ground or a single break in internal circuits of fire-alarm control unit.
 6. Abnormal ac voltage at fire-alarm control unit.
 7. Break in standby battery circuitry.
 8. Failure of battery charging.
 9. Abnormal position of any switch at fire-alarm control unit or annunciator.
- E. System Supervisory Signal Actions:
1. Initiate notification appliances.
 2. Identify specific device initiating the event at fire-alarm control unit and remote annunciators.
 3. After a time delay of 200 seconds, transmit a trouble or supervisory signal to the remote alarm receiving station.

2.3 FIRE-ALARM CONTROL UNIT

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Bosch Security Systems.
 2. Faraday.
 3. Fike Corporation.
 4. Fire-Lite Alarms.
 5. GAMEWELL.
 6. GE UTC Fire & Security; A United Technologies Company.
 7. Keltron Corporation.
 8. Mircom Technologies, Ltd.
 9. Notifier.
 10. Siemens Industry, Inc.; Fire Safety Division.
 11. Silent Knight.
 12. SimplexGrinnell LP.
- B. General Requirements for Fire-Alarm Control Unit:

1. Field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with UL 864.
 2. Addressable Initiation Device Circuits: The FACP shall indicate which communication zones have been silenced and shall provide selective silencing of alarm notification appliance by building communication zone.
 3. Addressable Control Circuits for Operation of Notification Appliances and Mechanical Equipment: The FACP shall be listed for releasing service.
- C. Alphanumeric Display and System Controls: Arranged for interface between human operator at fire-alarm control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.
1. Annunciator and Display: Liquid-crystal type, 80 characters, minimum.
 2. Keypad: Arranged to permit entry and execution of programming, display, and control commands.
- D. Initiating-Device, Notification-Appliance, and Signaling-Line Circuits:
1. Pathway Class Designations: NFPA 72: As determined by delegated designer.
 2. Pathway Survivability: As determined by delegated designer.
- E. Notification-Appliance Circuit:
1. Audible appliances shall sound in a three-pulse temporal pattern, as defined in NFPA 72.
 2. Where notification appliances provide signals to sleeping areas, the alarm signal shall be a 520-Hz square wave with an intensity 15 dB above the average ambient sound level or 5 dB above the maximum sound level, or at least 75 dBA, whichever is greater, measured at the pillow.
 3. Visual alarm appliances shall flash in synchronization where multiple appliances are in the same field of view, as defined in NFPA 72.
- F. Elevator Recall:
1. Elevator recall shall be initiated only by one of the following alarm-initiating devices:
 - a. Elevator lobby detectors except the lobby detector on the designated floor.
 - b. Smoke detector in elevator machine room.
 - c. Smoke detectors in elevator hoistway.
 2. Elevator controller shall be programmed to move the cars to the alternate recall floor if lobby detectors located on the designated recall floors are activated.
 3. Water-flow alarm connected to sprinkler in an elevator shaft and elevator machine room shall shut down elevators associated with the location without time delay.
 - a. Water-flow switch associated with the sprinkler in the elevator pit may have a delay to allow elevators to move to the designated floor.

- G. Door Controls: Door hold-open devices that are controlled by smoke detectors at doors in smoke-barrier walls shall be connected to fire-alarm system.
- H. Remote Smoke-Detector Sensitivity Adjustment: Controls shall select specific addressable smoke detectors for adjustment, display their current status and sensitivity settings, and change those settings. Allow controls to be used to program repetitive, time-scheduled, and automated changes in sensitivity of specific detector groups. Record sensitivity adjustments and sensitivity-adjustment schedule changes in system memory.
- I. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to a remote alarm station.
- J. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, supervisory and digital alarm communicator transmitters shall be powered by 24-V dc source.
 - 1. Alarm current draw of entire fire-alarm system shall not exceed 80 percent of the power-supply module rating.
- K. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.

2.4 MANUAL FIRE-ALARM BOXES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. AMSECO - A Potter Brand.
 - 2. Bosch Security Systems.
 - 3. Cooper Wheelock.
 - 4. Faraday.
 - 5. Federal Signal Corporation.
 - 6. Fike Corporation.
 - 7. Fire-Lite Alarms.
 - 8. GAMEWELL.
 - 9. GE UTC Fire & Security; A United Technologies Company.
 - 10. Keltron Corporation.
 - 11. Mircom Technologies, Ltd.
 - 12. Notifier.
 - 13. Siemens Industry, Inc.; Fire Safety Division.
 - 14. Silent Knight.
 - 15. SimplexGrinnell LP.
 - 16. System Sensor.
- B. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38.

1. Single-action mechanism, pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.
2. Station Reset: Key- or wrench-operated switch.

2.5 SYSTEM SMOKE DETECTORS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Bosch Security Systems.
2. Faraday.
3. Fenwal Protection Systems; A UTC Fire & Security Company.
4. Fire-Lite Alarms.
5. GAMEWELL.
6. GE UTC Fire & Security; A United Technologies Company.
7. Gentex Corporation.
8. Harrington Signal, Inc.
9. Keltron Corporation.
10. Mircom Technologies, Ltd.
11. Notifier.
12. Siemens Industry, Inc.; Fire Safety Division.
13. Silent Knight.
14. SimplexGrinnell LP.
15. System Sensor.

- B. General Requirements for System Smoke Detectors:

1. Comply with UL 268; operating at 24-V dc, nominal.
2. Detectors shall be two-wire type.
3. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
4. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
5. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
6. Integral Visual-Indicating Light: LED type, indicating detector has operated and power-on status.
7. Remote Control: Unless otherwise indicated, detectors shall be digital-addressable type, individually monitored at fire-alarm control unit for calibration, sensitivity, and alarm condition and individually adjustable for sensitivity by fire-alarm control unit.
 - a. Rate-of-rise temperature characteristic of combination smoke- and heat-detection units shall be selectable at fire-alarm control unit for 15 or 20 deg F (8 or 11 deg C) per minute.

- C. Photoelectric Smoke Detectors:

1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
 - a. Primary status.
 - b. Device type.
 - c. Present average value.
 - d. Present sensitivity selected.
 - e. Sensor range (normal, dirty, etc.).

D. Duct Smoke Detectors: Photoelectric type complying with UL 268A.

1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
 - a. Primary status.
 - b. Device type.
 - c. Present average value.
 - d. Present sensitivity selected.
 - e. Sensor range (normal, dirty, etc.).
3. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector for smoke detection in HVAC system ducts.
4. Each sensor shall have multiple levels of detection sensitivity.
5. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
6. Relay Fan Shutdown: Fully programmable relay rated to interrupt fan motor-control circuit.

2.6 HEAT DETECTORS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Bosch Security Systems.
2. Faraday.
3. Fire-Lite Alarms.
4. GAMEWELL.
5. GE UTC Fire & Security; A United Technologies Company.
6. Gentex Corporation.
7. Harrington Signal, Inc.
8. Keltron Corporation.
9. Mircom Technologies, Ltd.
10. Notifier.
11. Siemens Industry, Inc.; Fire Safety Division.
12. Silent Knight.

13. SimplexGrinnell LP.
14. System Sensor.

B. General Requirements for Heat Detectors: Comply with UL 521.

1. Temperature sensors shall test for and communicate the sensitivity range of the device.

C. Heat Detector, Combination Type: Actuated by either a fixed temperature or a rate of rise.

1. Mounting: Twist-lock base interchangeable with smoke-detector bases.
2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

2.7 NOTIFICATION APPLIANCES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Cooper Wheelock.
2. Federal Signal Corporation.
3. GE UTC Fire & Security; A United Technologies Company.
4. Gentex Corporation.
5. Harrington Signal, Inc.
6. Keltron Corporation.
7. Mircom Technologies, Ltd.
8. Siemens Industry, Inc.; Fire Safety Division.
9. SimplexGrinnell LP.
10. System Sensor.

B. General Requirements for Notification Appliances: Connected to notification-appliance signal circuits, zoned as indicated, equipped for mounting as indicated, and with screw terminals for system connections.

1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly, equipped for mounting as indicated, and with screw terminals for system connections.

C. Chimes: Vibrating type.

D. Horns: Electric-vibrating-polarized type, 24-V dc; with provision for housing the operating mechanism behind a grille. Comply with UL 464.

E. Visible Notification Appliances: Xenon strobe lights complying with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch- (25-mm-) high letters on the lens.

1. Mounting: Wall mounted unless otherwise indicated.

2. Flashing shall be in a temporal pattern, synchronized with other units.
3. Strobe Leads: Factory connected to screw terminals.
4. Mounting Faceplate: Factory finished, red.

2.8 REMOTE ANNUNCIATOR

- A. Description: Annunciator functions shall match those of fire-alarm control unit for alarm, supervisory, and trouble indications. Manual switching functions shall match those of fire-alarm control unit, including acknowledging, silencing, resetting, and testing.
 1. Mounting: Semi-flush cabinet, NEMA 250, Type 1.
- B. Display Type and Functional Performance: Alphanumeric display and LED indicating lights shall match those of fire-alarm control unit. Provide controls to acknowledge, silence, reset, and test functions for alarm, supervisory, and trouble signals.

2.9 ADDRESSABLE INTERFACE DEVICE

- A. General:
 1. Include address-setting means on the module.
 2. Store an internal identifying code for control panel use to identify the module type.
 3. Listed for controlling HVAC fan motor controllers.
- B. Monitor Module: Microelectronic module providing a system address for alarm-initiating devices for wired applications with normally open contacts.
- C. Integral Relay: Capable of providing a direct signal to elevator controller to initiate elevator recall to circuit-breaker shunt trip for power shutdown.
 1. Allow the control panel to switch the relay contacts on command.
 2. Have a minimum of two normally open and two normally closed contacts available for field wiring.
- D. Control Module:
 1. Operate notification devices.
 2. Operate solenoids for use in sprinkler service.

2.10 DIGITAL ALARM COMMUNICATOR TRANSMITTER

- A. Digital alarm communicator transmitter shall be acceptable to the remote central station and shall comply with UL 632.
- B. Functional Performance: Unit shall receive an alarm, supervisory, or trouble signal from fire-alarm control unit and automatically capture one telephone line(s) and dial a preset number for a remote central station. When contact is made with central station(s), signals shall be transmitted. If service on either line is interrupted for longer than 45

seconds, transmitter shall initiate a local trouble signal and transmit the signal indicating loss of telephone line to the remote alarm receiving station over the remaining line. Transmitter shall automatically report telephone service restoration to the central station. If service is lost on both telephone lines, transmitter shall initiate the local trouble signal.

- C. Local functions and display at the digital alarm communicator transmitter shall include the following:
1. Verification that both telephone lines are available.
 2. Programming device.
 3. LED display.
 4. Manual test report function and manual transmission clear indication.
 5. Communications failure with the central station or fire-alarm control unit.
- D. Digital data transmission shall include the following:
1. Address of the alarm-initiating device.
 2. Address of the supervisory signal.
 3. Address of the trouble-initiating device.
 4. Loss of ac supply.
 5. Loss of power.
 6. Low battery.
 7. Abnormal test signal.
 8. Communication bus failure.
- E. Secondary Power: Integral rechargeable battery and automatic charger.
- F. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

- A. Comply with NFPA 72, NFPA 101, and requirements of authorities having jurisdiction for installation and testing of fire-alarm equipment. Install all electrical wiring to comply with requirements in NFPA 70 including, but not limited to, Article 760, "Fire Alarm Systems."
- B. Install wall-mounted equipment, with tops of cabinets not more than 78 inches (1980 mm) above the finished floor.
- C. Manual Fire-Alarm Boxes:
1. Install manual fire-alarm box in the normal path of egress within 60 inches (1520 mm) of the exit doorway.
 2. Mount manual fire-alarm box on a background of a contrasting color.

3. The operable part of manual fire-alarm box shall be between 42 inches (1060 mm) and 48 inches (1220 mm) above floor level. All devices shall be mounted at the same height unless otherwise indicated.
- D. Smoke- or Heat-Detector Spacing: Comply with NFPA 72.
 - E. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of duct. Tubes more than 36 inches (9100 mm) long shall be supported at both ends.
 - F. Elevator Shafts: Coordinate temperature rating and location with sprinkler rating and location. Do not install smoke detectors in sprinklered elevator shafts.
 - G. Remote Status and Alarm Indicators: Install in a visible location near each smoke detector, sprinkler water-flow switch, and valve-tamper switch that is not readily visible from normal viewing position.
 - H. Audible Alarm-Indicating Devices: Install not less than 6 inches (150 mm) below the ceiling. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille. Install all devices at the same height unless otherwise indicated.
 - I. Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and at least 6 inches (150 mm) below the ceiling. Install all devices at the same height unless otherwise indicated.
 - J. Device Location-Indicating Lights: Locate in public space near the device they monitor.

3.2 PATHWAYS

- A. Pathways above recessed ceilings and in non-accessible locations may be routed exposed.
 1. Exposed pathways shall be installed in EMT.
- B. Exposed EMT shall be painted red enamel.

3.3 CONNECTIONS

- A. For fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, comply with requirements in Section 08 71 00 "Door Hardware." Connect hardware and devices to fire-alarm system.
 1. Verify that hardware and devices are listed for use with installed fire-alarm system before making connections.
- B. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 36 inches (910 mm) from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.

1. Electronically locked doors and access gates.
2. Alarm-initiating connection to elevator recall system and components.
3. Alarm-initiating connection to activate emergency lighting control.
4. Alarm-initiating connection to activate emergency shutoffs for gas and fuel supplies.
5. Supervisory connections at valve supervisory switches.
6. Supervisory connections at elevator shunt-trip breaker.
7. Supervisory connections at fire-extinguisher locations.

3.4 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."
- B. Install framed instructions in a location visible from fire-alarm control unit.

3.5 GROUNDING

- A. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control unit.
- B. Ground shielded cables at the control panel location only. Insulate shield at device location.

3.6 FIELD QUALITY CONTROL

- A. Field tests shall be witnessed by authorities having jurisdiction.
- B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 1. Visual Inspection: Conduct visual inspection prior to testing.
 - a. Inspection shall be based on completed record Drawings and system documentation that is required by NFPA 72 in its "Completion Documents, Preparation" table in the "Documentation" section of the "Fundamentals" chapter.
 - b. Comply with the "Visual Inspection Frequencies" table in the "Inspection" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.
 2. System Testing: Comply with the "Test Methods" table in the "Testing" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
 3. Test audible appliances for the public operating mode according to manufacturer's written instructions. Perform the test using a portable sound-level meter complying with Type 2 requirements in ANSI S1.4.

4. Test visible appliances for the public operating mode according to manufacturer's written instructions.
 5. Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" section of the "Fundamentals" chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
- C. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.
 - D. Fire-alarm system will be considered defective if it does not pass tests and inspections.
 - E. Prepare test and inspection reports.
 - F. Maintenance Test and Inspection: Perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.
 - G. Annual Test and Inspection: One year after date of Substantial Completion, test fire-alarm system complying with visual and testing inspection requirements in NFPA 72. Use forms developed for initial tests and inspections.

3.7 SOFTWARE SERVICE AGREEMENT

- A. Comply with UL 864.
- B. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.
- C. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.
 1. Upgrade Notice: At least 30 days to allow Owner to schedule access to system and to upgrade computer equipment if necessary.

3.8 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain fire-alarm system.

END OF SECTION 28 31 11

SECTION 31 05 19.13**GEOTEXTILE FABRIC, GEOCOMPOSITES AND BALLAST MATS****PART I - GENERAL****1.1 SUMMARY****A. Description**

This Section covers the furnishing and placing of filter fabric, subgrade geotextile, drainage geotextile fabric, silt fence and composite drainage material at locations shown on the Contract Drawings and as specified herein.

B. Related Sections

1. 31 22 00 – Site Preparation and Grading
2. 31 37 00 - Riprap
3. 31 25 00 – Erosion and Sedimentation Controls
4. 34 11 29 – General Track Construction
5. 34 11 23 - Special Trackwork
6. 33 46 00 - Subdrainage
7. KCMO Standards - Storm Drainage Systems

1.2 REFERENCES

<u>Sponsor</u>	<u>Number</u>	<u>Subject</u>
ASTM	D 1683	Failure in Sewn Seams of Woven Fabrics
ASTM	D 2263	Test for Tear Strength of Textile Materials
ASTM	D 3786	Hydraulic Bursting Strength of Knitted Goods and Non-woven: Diaphragm Bursting Strength Tester Method
ASTM	D 4354	Sampling of Geosynthetics for Testing
ASTM	D 4491	Water Permeability of Geotextiles by Permittivity
ASTM	D 4533	Trapezoid Testing Strength of Geotextiles
ASTM	D 4595	Tensile Properties of Geotextiles by the Wide-Width Strip Method
ASTM	D 4632	Grab Breaking Load and Elongation of Geotextiles
ASTM	D 4751	Determining the Apparent Opening Size of a Geotextile
ASTM	D 4759	Standard Practice for Determining Specification Conformance of Geosynthetics.
ASTM	D 4833 I	Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products

ASTM	D 4873	Standard Guide for Identification, Storage, and Handling of Geotextiles.
ASTM	D 5321	Standard Practice for Determining the Coefficient of Soil and Geosynthetic by Direct Shear.
ASTM	D 6213	Standard Tests to Evaluate the Chemical Resistance of Geogrids to Liquids.
ASTM	D 6637	Standard Test Method for Determining Tensile Properties of Geogrid.
FHWA-	SA-96-071	Mechanically Stabilized Earth Walls and Reinforced Soil Slopes Design and Construction Guidelines.
ASTM	D 5732	Test to Evaluate Stiffness of a Geosynthetic.
GRI	GG2-87	Test for Determining the Ultimate Strength of a Geogrid Junction
EPA	9090	Test to Evaluate the Effects of Chemicals on the Physical Properties of a Product

1.3 SUBMITTALS

- A. Submittals shall be made in accordance with the requirements of the General Provisions, except as modified herein.
- B. A certificate or affidavit attesting that the fabric meets all the requirements stated in these Specifications.
- C. The manufacturer's reported property values shall be based on the following sampling and testing requirements:
 - 1. Sample all geotextiles according to ASTM D 4354. The production unit used for sampling shall be a roll.
 - 2. Perform specified tests to determine geotextile properties for the intended applications. Test the tensile strength requirements in both machine and cross-machine directions.
- D. Where factory seams are made, the sheets of geotextile shall:
 - 1. Be sewn together using a lock-type stitch Type 301 or 401 as shown on the plans;
 - 2. Be sewn with polymeric thread that is at least 85 percent by weight polyolephins, polyester, or polyamides, and be as resistant to deterioration as the geotextile being sewn, nylon thread shall not be used; and
 - 3. Have test results showing that the seams meet or exceed 90 percent of the specified tensile strength minimum values for the intended applications.
- E. Samples:

1. Geotextiles and Geocomposites: One-piece, minimum 18 inches long, taken across full width of roll of each type and weight of geotextile or geocomposite furnished.
- F. Quality Control Submittals:
1. Certifications from each geotextile and geocomposite manufacturer furnished products have specified property values. Certified property values shall be either minimum or maximum average roll values, as appropriate, for materials furnished.
- G. Shop Drawings:
1. The Manufacturer shall submit detailed shop and installation drawings showing the location of all joints in the ballast mat and alignment of mats around all penetrations.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Label, handle and store product per ASTM D 4873.
- B. Delivery each roll with sufficient information attached to uniquely identify it for inventory and quality control.
- C. Handle products during shipment and on-site in a manner that maintains undamaged condition.
- D. Do not store products directly on ground. Ship and store geotextile and geocomposite materials with suitable wrapping for protection against moisture, ultraviolet exposure, and other weather elements. If stored outdoors, elevate and protect materials with waterproof cover.

1.5 SCHEDULING AND SEQUENCING

- A. Where geotextile and geocomposite is to be laid directly upon the ground surface, first prepare subgrade as specified in the appropriate Related Sections specified herein.

PART II - PRODUCTS

2.1 GEOTEXTILE FABRIC MATERIALS

- A. Pervious fabric sheet composed of strong rot proof polymeric fibers oriented into a stable network such that the fibers retain their relative positions with respect to each other. The fabric shall be free of any chemical treatment or coating which could significantly reduce permeability, and shall have no flaws or defects which could significantly alter its properties.
- B. Nonwoven geotextile shall be composed of continuous or discontinuous (staple) fibers held together through needle-punching or spun-bonding. Fabric edges shall be selvaged or otherwise finished to prevent outer material from pulling away from fabric. Unseamed roll width shall be a minimum of 14 feet. Conform to physical property requirements for the specific application herein.
- C. Woven Geotextile Fabric shall be a pervious sheet of polymeric yarn woven into a uniform pattern with distinct and measurable openings. Polymeric yarn shall consist of long-chain synthetic polymers with stabilizers to make filaments resistant to deterioration

due to heat and ultraviolet light exposure. Fabric edges shall be selvaged or otherwise finished to prevent outer material from pulling away from the fabric. Unseamed roll width shall be a minimum of 3 feet. Conform to physical requirements for the specific application herein.

D. Material Properties:

1. Subgrade Geotextile for use in track subgrade stabilization and Drainage Geotextile Fabric for use in underdrain: Non-woven Polypropylene, Polyester or Polyethylene

Unit Weight (ASTM-5261)	8 oz/yd ² , min
Water Permeability (k) (ASTM D 4491)	70 gal/min/sf, min.
Apparent Opening Size (U.S. Standard sieve) (ASTM D 4751)	70, or smaller.
Grab Tensile Strength (ASTM D 4632)	200 lb., min. @ 50%
Mullen Burst Strength (ASTM D 3786)	375 psi
Puncture Strength (ASTM D 4833)	80 lb., min
Trapezoidal Tear Strength (ASTM D 4533)	90 lb., min.
Abrasion Resistance	20% loss
Ultraviolet Radiation Resistance	70% strength retention/500 hrs

2. Geotextile for use in riprap bedding shall conform to the requirements in Section 31 37 00 – Riprap, Section 2.1.

3. Filter Fabric for use with walls: Nonwoven Polypropylene, Polyester or Polyethylene

Water Permittivity (ASTM D 4491)	100 gal/min/ft ⁵ , min.
Apparent Opening Size (U.S. Standard sieve) (ASTM D 4751)	70, max.
Puncture Strength (ASTM D 4833)	70 lbs., min.
Grab Strength (ASTM D 4632)	160 lbs., min.
Mullen Burst Strength (ASTM D 3786)	260 psi., min.
Trapezoidal Tear Strength (ASTM D 4533)	50 lbs., min.

4. Composite Drainage Material for use with walls: Composite Drainage Material shall be a first-quality, commercially available, Sheet Drain product. Sheet drain shall have a core consisting of double cusped material, single dimpled material,

or double dimpled material. Sheet drain core shall be made of polyethylene, high density polyethylene, or high impact polystyrene. Core shall be transversely surrounded by nonwoven geotextile manufactured integrally with the core material to form a composite product. Unsupported geotextile or geogrid without core is not acceptable.

Width/Length 1.5 feet/30 feet, min.

Compressive Strength 30 psi, min.

In Plane Flow Rate
grad = 0.1, press. = 5 psi 3 gal/min/ft, min.
grad = 0.1, press. = 14.5 psi 10 gal/min/ft, min

5. Silt Fence Fabrics: Woven Polypropylene, Polyester or Polyethylene Fabric

Grab Strength (ASTM D 4632) 125 lbs min.

Grab Elongation (ASTM D 4632) 25 %

Burst Strength (ASTM D 3786) 300 psi, min.

Puncture (ASTM D 4833) 80 lbs, min.

Tear(ASTM D 4533) 50 lbs, min.

Apparent Opening Size, 30 to 50
U.S. Sieve Number (ASTM D 4751)

Permitivity (ASTM D 4491) 30 gal/min/ft⁵, min.

2.2 ROADBED AGGREGATE GEOGRID

- A. Geogrids shall be a regular network of integrally connected polymer tensile elements constructed in a single layer with aperture geometry sufficient to permit significant mechanical interlock with the surrounding soil or rock. Geogrids must also be dimensionally stable and able to retain their geometry under manufacture, transport and installation.
- B. Use BX 1200 Biaxial Geogrid by Tensar or approved equal. Geogrids shall have the following properties:

GEOGRID PROPERTY VALUES

Geogrid Properties	Test Method	Machine Direction MD	Perpendicular to Machine Direction CMD
Type of Geogrid		Punched and Drawn	Punched and Drawn
Aperture Size	Nominal Dimensions	Minimum – 0.8 in Maximum – 1.3 in	Minimum – 0.8 in Maximum – 1.3 in
Rib Thickness	Nominal Dimensions	Minimum - 0.05 in	Minimum – 0.05 in
Tensile Strength at 2% Strain	ASTM D66371	Minimum – 410 lb/ft	Minimum – 590 lb/ft

Flexural Stiffness	ASTM D-5732-952	Min. 750,000 mg-cm	NA
True Initial Modulus in Use	ASTM 66371	Minimum – 27420 lb/ft	Minimum – 44550 lb/ft
Junction Efficiency	GRI-GG2-87	93%	93%
Aperture Stability	U.S. Army Corps of Engineers Methodology	6.5 kg-cm/deg	NA
Resistance to Long Term Degradation	EPA 9090 Immersion Testing	100%	100%

1. Resistance to elongation when initially subjected to load measured via ASTM 6637 without deforming test materials under load before measuring such resistance or employing “secant” or “offset” tangent methods of measurement.
 2. Resistance to bending force measured via ASTM D-5732-95, using specimens of width two ribs wide, with transverse ribs cut flush with exterior edges of longitudinal ribs (as a “ladder”), and of length sufficiently long to enable measurement of the overhang dimension. The overall Flexural Stiffness is calculated as the square root of the product of machine-and cross-machine-direction Flexural Stiffness values.
 3. Unless indicated otherwise, values shown are minimum average roll values determined in accordance with ASTM D-4759.
- C. Multiple layers of geogrid used to meet the requirements set forth in the preceding table shall not be accepted.
- D. Alternate geogrid materials will be considered. Such materials must be pre-approved in writing by the Engineer, prior to bid.

2.3 BALLAST MATS

- A. A ballast mat shall consist of natural rubber with fabric reinforcement designed to provide reduction in the impact on structures of ground or structure-borne vibrations. The upper surface of the mat shall be textured to permit ballast to nest for trackbed stability and contain synthetic elastomers for protection against attack by contaminants that may filter through ballast over time. The subsurface shall contain fabric reinforcement for strength and load distribution. Its underside shall provide a regular pattern of projections in the form of truncated cones.
- B. Ballast Mat material shall satisfy the following requirements:
1. Capacity – Axle Load (Approx.): 33 Tons
 2. Dimensions:
 - a. Width - No less than 54” not including joint overlaps
 - b. Thickness – 7/8”
 - c. Length – 30’ maximum
 3. Fabric (Fiberglass-coated PVC)’
 - a. Tensile Strength – 60 pounds/inch
 - b. Elongation at Break – 10%

4. Elastomer Properties: Natural rubber unless otherwise specified
5. Top Layer (synthetic):
 - a. 3/16", 1-ply fabric
6. Isolating Layer:
 - a. 5/8"
7. Ballast Mat:
 - a. Tensile Strength – 200 psi
 - b. Elongation at Break – 100%
 - c. Tear Resistance – 50 pounds/inch
 - d. Hardness (Shore A) = 53 (\pm 7)
8. Dynamics – Dynamic to static stiffness ration K_d related to a preload of 8.5 psi = 1.86
9. Temperature Range – Standard quality is suitable for service where ballast mat temperatures range between -4°F and +158°F.
10. The material used for sealing of the ballast mat joints shall be an integral extension of the top surface of the mat or a separate material having strength characteristics equal to those of the top layer of the ballast mat.

PART III - EXECUTION

3.1 PLACEMENT METHOD FOR GEOTEXTILE FABRIC AND GEOGRID

- A. Geotextile fabric shall be placed at locations shown on the Contract Drawings, or as specified. Fabric shall be unrolled directly on the soil surface to the line and dimensions shown on the Contract Drawings. The Contractor shall place subsequent or overlying material in such a way as to not tear, puncture or shift the fabric. Tears or rips in the filter fabric shall be patched with fabric lapped in accordance with the overlap requirements herein. Tracked equipment shall not be permitted on the filter fabric covered subgrade. Aggregates shall not be dropped onto the fabric from a height which causes damage to the fabric.
- B. Backfill or borrow material shall be placed over filter fabric and compacted according to Section 31 22 00.

3.2 DRAINAGE GEOTEXTILE PLACEMENT

- A. Fabric shall be placed in the trench according to the project plans. Overlapping along the longitudinal drain axis shall be a minimum of 18 inches. Damaged fabric shall be repaired by placing new fabric over the damaged area meeting the overlap requirements.
- B. Assure intimate contact between the filter fabric and soil by exercising care during excavation and placement of the fabric. Place the geotextile loose enough to conform to the soil surface and without wrinkles.
- C. Prevent clogging by removing or otherwise preventing contact with very soft soil and muddy water in the excavation.

- D. Exercise caution while placing overlying drain rock onto the filter fabric to prevent cutting of the fabric. Damaged fabric shall be repaired by placing new fabric over the damaged area meeting the overlap requirements.
- E. Fabrics shall be covered as soon as possible after being placed, but not later than seven (7) calendar days after placement. Fabrics left uncovered for more than seven (7) calendar days shall be removed and rejected.

3.3 SUBGRADE GEOTEXTILE PLACEMENT FOR TRACK

- A. Prior to placement of Subgrade Geotextile fabric, the Contractor shall construct a prepared subgrade in accordance with the plans and specifications. Subgrade geotextile fabric shall be aligned and placed in a manner free of wrinkles. The preceding roll shall overlap the following roll a minimum of 18 inches in the direction the material is being spread. Place fabric with long dimension of each sheet parallel to direction of track, unless otherwise directed or approved by Engineer.
- B. Equipment or vehicles operation on the fabric shall be minimized. Damaged fabric may be repaired, by placing new fabric over the damaged area meeting overlap requirements. Where possible, aggregate shall be dumped at least 15 feet from the edge of previously constructed base and pushed onto the fabric with push type equipment.
- C. Normal traffic will be allowed only after aggregate layers have been placed to a minimum thickness of 6 inches and Contractor has demonstrated to Engineers satisfaction that damage to the geotextile will not result.
- D. Place subgrade geotextile centered under the centerline of the track varying no more than 6 inches left or right of centerline, or as otherwise shown or directed by Engineer.

3.4 GRANULAR BASE REINFORCEMENT

- A. Place geogrid at the proper elevation and alignment as shown on the construction drawings. Install geogrid in accordance with the installation guidelines provided by the manufacturer. Geogrid may be temporarily secured in place with ties, staples, pins, sand bags or backfill as required by fill properties, fill placement or weather conditions.
- B. Granular fill material shall be placed, spread, and compacted in such a manner that minimizes the development of wrinkles in the geogrid and/or movement of the geogrid.
- C. A minimum loose fill thickness of 6 inches is required prior to operation of tracked vehicles over the geogrid. Turning of tracked vehicles should be kept to a minimum to prevent tracks from displacing the fill and damaging the geogrid. If subgrade conditions permit, rubber-tired equipment may pass over the geogrid reinforcement at slow speeds (less than 10 mph) when integrally-formed geogrids are used. When woven, multi-layer or welded strip geogrids are used, rubber-tired equipment shall not be allowed directly on the geogrid. Sudden braking and sharp turning movements shall be avoided.
- D. Any roll of geogrid damaged before, during and/or after installation shall be replaced by the Contractor. Proper replacement shall consist of replacing the affected area and overlapping the geogrid per the manufacture's recommendations.

3.5 GEOGRID PLACEMENT

- A. Install geogrid per manufacturer's recommendations.

- B. Place geogrid on top of geotextile fabric.
- C. Do not fold.
- D. Overlap panels in the direction of fill placement.
- E. Provide geogrid overlap as follows.

Reinforcement Geogrid Overlaps	
Soil CBR Rating	Recommended Overlap
3+	1.0 feet
2 – 3	2.0 feet
1 – 2	2.0 feet
< 1	3.0 feet

3.6 SILT FENCE FOR EROSION CONTROL

Silt fencing for erosion control shall be installed in accordance with Section 31 25 00.

3.7 FILTER FABRIC AND COMPOSITE DRAINAGE MATERIAL FOR WALLS

Filter fabric and composite drainage materials for walls shall be installed in accordance with article Placement Method, herein.

3.8 SECURING FABRIC

Secure fabric during installation as necessary with sand bags, or other means approved by the Engineer.

3.9 PLACING PRODUCTS OVER FABRIC

- A. Do not install overlying products or materials until Engineer provides authorization to proceed.
- B. If large wrinkles develop in fabric during placement of overlying product, fold wrinkles flat in direction of placement. Maintain minimum overlap and fabric continuity as overlying product is placed.
- C. If fabric is damaged during placement of overlying products, remove overlying products as necessary to expose damaged area, and repair by placing new fabric over the damaged area meeting the overlap requirements.

3.10 BALLAST MAT INSTALLATION

- A. Ballast Mats shall be placed at locations shown on the Contract Drawings, or as specified.
- B. Install the mats in accordance with the Manufacturer's recommendations and instructions. Overlap the mat sections as required by the instructions.
- C. Cut ends of the ballast mat rolls square and in a neat straight line. Seal the joint with repair tape as specified by the ballast mat Manufacturer.

- D. The Contractor shall exercise extreme care to prevent the intrusion of silt and debris into the void space between the cones of the ballast mat. Protect the joints and place the A-fastener strips over the edges of the ballast mat.

PART IV - MEASUREMENT

- 4.1 Measurement** – No Separate measurement will be made for Work described in this Section.

PART V - PAYMENT

- 5.1 Payment** – No separate payment will be made for the Work described in this Section. All costs pertaining thereto shall be included in the Contract Unit Prices for other items as listed in the Bid Form-Unit Prices.

END OF SECTION

SECTION 31 13 00**TREE REMOVAL****PART 1 - GENERAL**

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes general removal of existing trees and plants that are affected by execution of the Work, whether temporary or permanent construction.
- B. Related Sections:
1. Section 01 56 39 "Temporary Tree and Plant Protection and Pruning" for protection of existing landscape material to remain, and pruning methods.
 2. Section 32 93 00 "Plants" for replacement plant installation.

1.3 DEFINITIONS

- A. Caliper: Diameter of a trunk measured by a diameter tape at 6 inches above the ground for trees up to, and including, 4-inch size; and 12 inches above the ground for trees larger than 4-inch size.
- B. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

1.4 GENERAL

- A. The CONTRACTOR is to use appropriate precautions when working near trees and shrubs along the grading limits to prevent unnecessary damages to them. The CONTRACTOR will be responsible for any damage caused by careless or reckless work in the vicinity of any trees or vegetation located outside of the construction easements. All damages to trees outside of the construction easements are to be reported, and immediate repair or care efforts will be coordinated with the OWNER and OWNER'S REPRESENTATIVE.
- B. The CONTRACTOR shall notify businesses of the impending construction start date so that they may have ample time to relocate any favored vegetation. Notification shall be at least one week in advance of any construction that will affect their property.

PART 2 – PRODUCTS

None Used

PART 3 - EXECUTION**1.1 TREE REMOVAL**

- A. All existing trees and vegetation to be removed, as noted on the plans, shall be removed unless otherwise directed by the owner's representative or the plan set. The CONTRACTOR shall be responsible for determining the exact quantity of trees to be removed within the project limits for bid purposes. There will be no additional payment for removal of trees within the project limits, which are not shown on the plans.
- B. All trees listed in the Removal of Improvements shall be removed unless otherwise directed by the owner's representative.
- C. The CONTRACTOR is directed to protect all existing trees not shown to be removed in the plan set.
- D. The CONTRACTOR may trim or remove other trees only if shown on the plans or determined necessary by the ENGINEER at the time of construction.
- E. Only trees marked "Replace" shall be replaced. Replacement trees shall be of like kind and of nursery stock size. See planting detail.
- F. Trees shall be completely removed with stump ground down to a minimum depth of 3'-0" of planter depth.
- G. Organic materials removed shall be legally disposed of off-site.

PART 4 - MEASUREMENT

4.1 Measurement – No Separate measurement will be made for Work described in this Section.

PART 5 - PAYMENT

5.1 Payment – No separate payment will be made for tree removals, relocations, or replacements. All costs pertaining thereto shall be included in the Contract Unit Prices for other items as listed in the Bid Form-Unit Prices.

END OF SECTION

SECTION 31 22 00**SITE PREPARATION AND GRADING****PART 1 - GENERAL****1.01 SCOPE OF WORK**

- A. Furnish all labor, materials, equipment and incidentals required and perform all excavation work and grading; place and compact backfill and fill; and dispose of unsuitable, waste and surplus materials as shown on the Drawings and as specified in American Public Works Association Standard Specifications and Design Criteria Section 2100 as revised, adopted, and provided by the Director of Kansas City, Missouri Public Works current at the time of bidding.
- B. Obtain all permits required for site preparation work prior to proceeding with the work.

1.02 REFERENCE STANDARDS

- A. In addition to complying with all pertinent codes and regulations, comply with the referenced or applicable portions of the American Public Works Association Standard Specifications and Design Criteria, as revised, adopted, and provided by the Director of Kansas City, Missouri current at the time of bidding.
- B. The following standards are referenced directly in this section. The latest version of these standards shall be used.

ASTM

D638 – Standard Test Method for Tensile Properties of Plastics

D698 – Test Method for Laboratory Compaction Characteristics of Soil Using
Standard Effort (12,400 ft-lbf/ft² (600 kN-m/m³))D4318 – Method of Test for Liquid Limit, Plastic Limit, and Plasticity Index of
Soils**PART 2 - PRODUCTS (NOT USED)****PART 3 - EXECUTION****3.01 CONSTRUCTION DETAILS****A. General**

- 1. The Contractor shall adhere to any and all statutes regarding the notification of utilities prior to beginning any work within public right-of-way. Relocation or protection of any existing utilities located in street right-of-way that lies within a utility easement and is endangered by this construction shall be the responsibility of the Contractor.

2. The Contractor shall make every reasonable effort to protect private facilities. These facilities may not be shown on the plans. When these facilities are disturbed or damaged by the work, the Contractor shall make necessary arrangements for repairs to the facilities for continuous service prior to the close of that work day.
3. It shall be the responsibility of the Contractor to protect all property lot corners and control monumentation. Should it be necessary to disturb any such monument, whether stake, pin, bar, disk, box, or other, it remains the responsibility of the Contractor to reference such markers prior to removal, reset, them, and file such relocations or monumentation documents as the law may require. Any such references, removal, replacement and certification of monuments shall be performed by a registered licensed surveyor. A copy of all such certification documents shall be provided to the Engineer prior to final payment. Any monument destroyed or improperly reset by the Contractor may be replaced by the Engineer to the standards required by law at the expense of the Contractor.
4. Grading, excavation and backfilling for all improvements shall be made to the lines, grades and cross sections indicated by the plans.
5. In addition, to any erosion control measures shown on the plans, the Contractor shall schedule and conduct his operations in such a manner and shall provide any necessary control facilities to protect downstream and adjacent properties from pollution, sedimentation or erosion caused by the grading operations. Any pollution or damage occurring shall be the responsibility of the Contractor.
6. During construction, the graded area shall be maintained by the Contractor in such condition that it will be well drained at all times. Roadway ditches, channel changes, inlet and outlet ditches and other ditches in connection with the roadway shall be cut and maintained to the required cross section. All drainage work shall be performed in proper sequence with other operations. All ditches and channels shall be kept free of debris or obstructions.

3.02 CLEARING, GRUBBING, AND DEMOLITION

A. Description

1. Clearing

- a. Clearing shall consist of removing all vegetative matter such as trees, brush, downed timber, and other objectionable materials found on or above the surface of the site. It shall include: removing buildings, fences, and lumber; waste dumps and trash; salvaging of such materials as may be specified; and disposing of the debris as per public entity requirements. Scalping shall include the removal of material such as sod, grass, residue or agricultural crops, and decayed vegetative matter from the surface of the ground without removing more earth than is necessary. Perimeter erosion and sediment controls must be in place before clearing activities occur.

2. Grubbing

- a. Grubbing shall consist of removing and disposing of all vegetative matter such as stumps, roots, buried trees, and brush encountered below the surface of the ground or subgrade, whichever is lower, that has not been included in the description of clearing.
- b. In all cases of grubbing, the vegetative matter shall be removed to a minimum depth of 12 inches below ground line or subgrade, whichever is lower, except as provided in the description of demolition and removal.
- c. When deleterious materials are encountered below the ground line which may be detrimental to the proposed improvement, they shall be removed to a depth necessary to provide adequate support for the proposed improvement.

3. Demolition and Removal

- a. This work shall consist of demolishing, removing, and disposing of all structures and improvements within the construction limits unless included in other items of work as shown on the plans or in the Special Provisions. This work shall apply to all structures and improvements whether on, above, or below the surface of the ground or subgrade.
- b. Demolition and removal shall include, but not be limited to, items such as buildings, drainage structures, pipes, pavements, fences, retaining walls, guardrails, and signs.
- c. Items such as fences and guardrails shall be salvaged and relinquished to the appropriate owner or relocated, where indicated on the plans.
- d. Relocation of signs, fences, guardrails, etc. shall be considered incidental to removal work except where such relocation is listed separately in the Itemized Proposal or the Special Provisions.
- e. All pipes that are to be abandoned shall be removed unless otherwise shown on the plans or approved by the Engineer.

B. Construction Specifications:

1. Limits of Work

- a. The limits of clearing, grubbing, and demolition shall extend to the construction limits unless otherwise shown on the plans. Clearing should only occur in those areas required for construction within a six month period. Where possible, large projects should be cleared and grubbed as construction progresses. Mass clearing and grubbing should be avoided. An undisturbed strip of not less than 25 feet in width of existing grass or other vegetation should be kept in place around the perimeter of the construction site, where possible, and protected from damage. The Contractor shall scalp

only those excavation and embankment areas necessary for construction of the project.

- b. Existing structures within or adjacent to the construction limits which are not to be removed or demolished shall be protected by the Contractor during construction. Any private facilities, such as house sewer laterals, that are disturbed or damaged by the Contractor's work shall be repaired by the Contractor prior to the close of the workday. This repair shall be made in a manner sufficient to restore utility service to that property.
- c. Perimeter Erosion and Sediment Controls: Perimeter controls will be put in place prior to the start of clearing and grubbing of the site. It is possible some clearing and grubbing will need to be done to accommodate the installation of some perimeter controls.

2. Embankment Areas

- a. Where undisturbed stumps and roots are encountered where the fill depth will exceed 3 feet, the stumps and roots may be left in place provided they do not extend more than 3 inches above the original ground line.

3. Borrow Areas

- a. All stumps, roots, and other objectionable matter shall be removed from the borrow material used for embankment or fill. The borrow area shall be left in a well drained and smooth condition.

4. Backfilling the Site

- a. All trenches, holes, pits, and basement areas resulting from clearing, grubbing, demolition, or removal on the site shall be backfilled with suitable material placed and compacted in conformance with this section.

5. Disposal of Materials

- a. All materials, with the exception of those that are designated for salvage or embankment, shall become the Contractor's property and shall be disposed of by the Contractor, outside the project limits.

6. Items to be Left in Place

- a. In removing concrete pavements, curbs, curb and gutter, sidewalks, and similar objects where portions of these objects are to be left in place, they shall be removed to an existing or new joint and sawed to a minimum depth of 2 inches or $\frac{1}{4}$ the slab thickness, whichever is greater. This joint shall be to true line and vertical face. Sufficient portions of these items shall be removed to provide the proper grade and connection to the new work.

3.03 LAND GRADING

A. Description

1. Grading

- a. Grading, as used herein, shall mean the performance of all excavation, embankment, and backfill in connection with the construction of all improvements. Mass grading should be avoided. An undisturbed strip of existing grass or other vegetation should be kept in place around the perimeter of the construction site where possible. The Contractor shall scalp only those excavation and embankment areas necessary for construction of the project.

2. Excavation

- a. Excavation is defined as the removal of materials from the construction area to the lines and grades shown on the plans.

1) Unclassified Excavation

- i. Unclassified excavation is defined as the removal of all material encountered regardless of its nature. All material excavated will be considered as Unclassified Excavation unless the Special Provisions specify Classified Materials.

b. Rock Excavation

- 1) Rock excavation is defined as the removal of all rock ledges 6 inches or more in thickness, detached rock or boulders having a volume of more than 1 ½ cubic yards, and shale occurring in its natural state, hard and unweathered.
- 2) A rock ledge is defined as a continuous body of rock that may not include thin interbedded seams of shale or other soft materials less than 12 inches thick. The vertical limit of each ledge shall be defined by interbedded seams of soft materials 12 inches or more in thickness. The beds of soft interbedded material 12 inches or more in thickness shall not be included in the measurement for Rock Excavation but shall be included in the measurement for Earth Excavation.

3. Embankment or Backfill

- a. Embankment or backfill is defined as the placing and compacting of material in the construction area to the lines and grades as shown on the plans.

1) Unsuitable Material

- i. Unsuitable material is defined as muck, frozen material, organic material, top soil, rubbish, and rock with a maximum dimension greater than 24 inches.

2) Suitable Material

- i. Suitable material is defined as entirely imperishable with that portion passing the No. 40 sieve having a liquid limit not exceeding 40 and a plastic index not exceeding 25 when tested in accordance with ASTM D-4318.

3) Rock Embankment

- i. Material for rock embankment shall be free of unsuitable material and shall contain, by volume, greater than 10 percent rock or gravel having a maximum dimension greater than 3 inches, but not greater than 24 inches.

4) Earth Embankment

- i. Material for earth embankment shall be free of unsuitable material and shall contain, by volume, less than 10 percent rock or gravel having a maximum dimension greater than 3 inches.

5) Borrow

- i. Borrow is defined as approved material excavated from an area outside of the project limits and required for construction of embankments.

6) Waste

- i. Waste is defined as excavation material that is not used in embankments and is disposed of outside of the embankment areas.

7) Structures

- i. Structures, as used herein, refer to bridges, culverts, storm sewer and sanitary appurtenances, retaining walls, and similar construction.

B. Application

1. This practice is applicable where grading to a planned elevation is necessary and practical for the proposed development of a site and for proper operation of sediment control practices.

C. Construction Specifications:

1. General

- a. Construct and maintain all erosion and sediment control practices and measures in accordance with the approved erosion and sediment control plan and construction schedule.

- b. Remove good topsoil from areas to be graded and filled and preserve it for use in the final grading of all critical areas. Earth Excavation: Earth excavation is defined as the removal of all material not defined as rock.
- c. Scarify areas to be topsoiled to a minimum depth of 2 inches before placing topsoil.
- d. Clear and grub areas to be filled to remove trees, vegetation, roots, or other objectionable material that would affect the planned stability of the fill.
- e. Ensure that fill material is free of brush, rubbish, rocks, logs, stumps, building debris, and other materials inappropriate for constructing stable fills.
- f. Place all fill in layers not to exceed 9 inches in thickness (dependent on compaction method see Geotechnical Report), and compact the layers as required to reduce erosion, slippage, settlement, or other related problems.
- g. Do not incorporate frozen or soft, mucky, or highly compressible materials into fill slopes.
- h. Do not place fill on a frozen foundation due to possible subsidence and slippage.
- i. Keep diversions and other water conveyance measures free of sediment during all phases of development.
- j. Handle seeps or springs encountered during construction in accordance with State Agency-approved methods.
- k. Permanently stabilize all graded areas immediately after final grading is completed on each area in the grading plan. Apply temporary stabilization measures within 14 days on all graded areas when work is to be interrupted or delayed for 30 calendar days or longer.
- l. Show topsoil stockpiles, borrow areas, and spoil areas on the plans, and make sure they are adequately protected from erosion. Include final stabilization of these areas in the plan.

2. Excavation

- a. All suitable material removed by excavation shall be used as far as practicable in the formation of embankment as required to complete the work. The Contractor shall sort all excavated material and stockpile when necessary, so as to provide suitable materials for embankments.
- b. After removal of the roadway excavation material to the required section, all material between lines 1 foot (30.48 cm) outside of the curbs and within the top 6 inches (15.24 cm) of the subgrade shall be compacted to

95 percent of maximum density for the material as defined in Section 31 22 00.

- c. Rock encountered within the full width of the roadway, toe of slope to toe of slope, shall be undergraded to an elevation of 6 inches (15.24 cm) below the finished subgrade elevation. Rock shall be removed in such a manner as to leave no excessive water pockets in the surface.
- d. Areas of undergrading or overbreak in rock between lines 1 foot (30.48 cm) outside of the curbs shall be backfilled with spalls, rock fragments or a granular type material. Backfill materials shall have a plasticity index not to exceed 10 and a gradation such that at least 50 percent of the material will be retained on the No. 4 (4.75 mm) Sieve.
- e. Undergrading
 - 1) Where materials are encountered which are deemed as unsuitable by the Engineer or as defined in the Geotechnical Report, for use in the work, they shall be removed to the depth and limits as ordered by the Engineer. Areas undergraded shall be backfilled with one of the following materials:
 - i. A granular type material having a plasticity index not to exceed 10 and a gradation such that at least 50 percent of the material will be retained on the No.4 (4.75 mm) Sieve and not more than 40 percent will pass the No. 10 (2.00 mm) Sieve. Dependent upon the location of undergrading the required granular material shall comply with the specified granular material.
 - ii. A material meeting the requirements of Embankment or Backfill above.

3. Starting the Embankment

- a. The existing surface upon which embankment material is to be placed shall have all unstable and unsuitable material removed before starting the embankment work.
- b. Where embankments 2 feet (60.96 cm) or less in depth are to be placed on areas covered by existing pavement, the existing pavement shall be removed and the cleared ground surface shall be compacted to the specified density. Where embankments greater than 2 feet (60.96 cm) in depth are to be placed on areas covered by existing pavement, the existing pavement shall be broken into pieces not larger than 24 inches (60.96 cm) maximum dimension, left in place and the embankment started thereon.
- c. Where embankments, regardless of height, are placed against hillsides or existing embankments, either of which have a slope steeper than 1 vertical to 4 horizontal, the existing slope shall be benched or stepped in maximum 36 inch rises and should be wide enough to accommodate

compaction equipment. The new fill shall be brought up in 9 inches or less layers or lifts in loose thickness when heavy, self-propelled compaction equipment is used; 4 to 6 inches in loose thickness when hand-guided equipment (i.e. jumping jack or plate compactor) is used. The material bladed out, the bottom of the area cut into, and the embankment material being placed, shall be compacted to the required density. Material cut out, bladed into place and compacted shall not be measured and paid for directly but will be considered as incidental work.

4. Placing Embankment

- a. **Placing Earth Embankment:** Earth shall be placed in successive horizontal layers, wetted or dried as necessary to be within the required moisture range and distributed uniformly over the full width of the embankment area. Each layer of material shall not exceed 9 inches or less layers or lifts in loose thickness when heavy, self-propelled compaction equipment is used and 4 to 6 inches in loose thickness when hand-guided equipment (i.e. jumping jack or plate compactor) is used and shall be compacted to not less than the required density before the next layer is placed thereon. Compaction equipment shall be approved by the Engineer prior to use. As the compaction of each layer progresses, continuous blading, or dozing will be required to level the surface and to insure uniform compaction. Embankment construction shall not be performed when material contains frost, is frozen or is snow covered.
- b. **Placing Earth and Rock Embankment:** When earth and stone or rock fragments are mixed in the embankment, all stones or rock fragments exceeding the thickness of the compacted lift shall be disposed of by being incorporated into the embankment outside the limits of the proposed surfaced areas. The thickness of the layer in these areas may be increased if necessary to accommodate the rocks, but shall not exceed 24 inches (60.96 cm) in thickness (loose state). The stones or rock fragments are to be placed so there will be no nesting. Compaction equipment shall be approved as required in the above paragraph.
- c. **Consolidated Rock Embankment:** When the excavated material consists predominantly of stone or rock fragments of such size that the material cannot be placed in layers of the thickness prescribed, such material shall be placed in the embankment in layers having a thickness of the approximate average size of the larger rocks but not to exceed 24 inches (60.96 cm). Rocks or boulders too large to permit placing in a 24 inch (60.96 cm) layer shall be reduced in size as necessary to permit placement. Rock shall not be dumped in place but shall be distributed by blading or dozing in a manner to insure proper placement in final position in the embankment. The spalls and smaller stone fragments shall be left on the surface of each layer as formed. Each layer shall be thoroughly consolidated before the next layer is placed. The top 12 inches (30.48 cm) of the embankment shall not contain material having a maximum dimension greater than 3 inches (7.62 cm). The rock fragments or crushed stone shall be well graded to form a dense mass when compacted

5. Compacting the Embankment

- a. Before placing any embankment, the surface of the existing ground shall be prepared as heretofore specified, moistened as required, and the top 6 inches (15.24 cm) compacted to a density of 90 percent as prescribed by the following paragraph.
- b. All embankment shall be compacted to a density of at least 95 percent of the maximum standard Proctor dry density for the material used as determined by ASTM D-698 and within a tolerance of minus 2 percent and plus 2 percent of the optimum moisture content value at maximum density as determined by the standard Proctor test at the time of placement and compaction. In addition to the above required compaction, the subgrade between lines 1 foot (30.48 cm) outside of the curbs and within the top 6 inches (15.24 cm) of the subgrade shall be compacted to a density of at least 95 percent of the maximum density for material used as determined by ASTM D-698 and with a tolerance of minus 2 percent and plus 2 percent of the optimum moisture at maximum density as determined by the Moisture Density Curve obtained.
- c. All the work involved in either adding moisture to or removing moisture from embankment materials to within these moisture limits shall be considered incidental to the completion of the grading operation.
- d. The Contractor shall reference and be responsible for following guidelines as stated in the Geotechnical Report.

D. Testing

1. Moisture - Density Determination

- a. In-place density and moisture content of the embankment will be determined by the Standard Proctor Test (ASTM D-698).
- b. All testing shall be performed by an independent testing agency and all coordination shall be the responsibility of the Contractor at no additional cost to the City or the Engineer.
- c. All test reports shall be submitted and approved by the Engineer prior to pavement construction. Should the results of the in-place density tests indicate the specified moisture or compaction limits have not been met, the area represented by the test shall be reworked and retested as required until the specified moisture and compaction requirements are achieved.

E. Inspection and Maintenance

1. Periodically check all graded areas and their associated erosion and sediment control practices, especially after rainfall events of ½-inch or greater. Promptly

remove all sediment from diversions and other control devices. If washouts or breaks occur, repair them immediately.

3.04 TOPSOILING

A. Description

1. Topsoiling is a method of preserving and reusing the surface layer of undisturbed soil, which is often enriched in organic matter, to obtain a more desirable planting and growth medium.

B. Application

1. Topsoiling provides a suitable growth medium for final site vegetative stabilization.
 - a. Where the preservation or importation of topsoil is determined to be the most effective method of providing a suitable growth medium.
 - b. Where the subsoil or existing soil presents the following problems:
 - 1) The texture, pH, or nutrient balance of the available soil cannot be modified by reasonable means to provide an adequate growth medium.
 - 2) The soil material is too shallow to provide an adequate root zone and to supply necessary moisture and nutrients for plant growth.
 - 3) The soil contains substances potentially toxic to plant growth.
 - c. Where high-quality turf is desirable to withstand intense use or meet aesthetic requirements.
 - d. Where ornamental plants will be established.
 - e. Only on slopes that are 2H:1V or flatter unless other measures are taken to prevent erosion and sloughing.

C. Construction Specifications

1. Materials

- a. Field exploration of the site shall be made to determine if there is sufficient surface soil of good quality to justify stripping. Topsoil shall be friable and loamy: loam, sandy loam, silt loam, sandy clay loam, or clay loam. It shall be free of debris, trash, stumps, rocks, root, and noxious weeds and shall give evidence of being able to support healthy vegetation. It shall contain no substance that is potentially toxic to plant growth.

2. Stripping

- a. Topsoil operations should not be performed when the soil is wet or frozen. Stripping shall be confined to the immediate construction area. Stripping depth may vary depending on the particular soil. All perimeter dikes, basins, and other sediment controls shall be in place prior to stripping.

3. Stockpiling

- a. Topsoil shall be stockpiled in such a manner that natural drainage is not obstructed and no off-site sediment damage results. Side slopes of the stockpile shall not exceed 2H:1V. Perimeter controls must be placed around the stockpile immediately.

4. Site Preparation

- a. Before topsoiling, establish needed erosion and sediment control practices such as diversions, grade stabilization structures, berms, dikes, level spreaders, waterways, sediment basins, etc. These practices must be maintained during topsoiling.
- b. Previously established grades on the areas to be topsoiled shall be maintained according to the approved plan. Where the pH of the subsoil is 6.0 or less or the soil is composed of heavy clays, agricultural limestone shall be spread in accordance with the soil test. After the areas to be topsoiled have been brought to grade, and immediately prior to dumping and spreading the topsoil, the subgrade shall be loosened by discing or scarifying to a depth of at least 2 inches to ensure bonding of the topsoil and subsoil.

5. Applying Topsoil

- a. Topsoil shall not be placed while in a frozen or muddy condition, when topsoil or subgrade is excessively wet, or in a condition that may otherwise be detrimental to proper grading or proposed sodding or seeding. The topsoil shall be uniformly distributed to a minimum compacted depth of 4 inches. It is necessary to compact the topsoil enough to ensure good contact with the underlying soil and to obtain a level seed bed for the establishment of high maintenance turf. However, undue compaction is to be avoided as it increases runoff velocity and volume and deters seed germination.

END OF SECTION 31 22 00

SECTION 31 22 19**FINISH GRADING****PART I - GENERAL****1.1 SUMMARY****A. Description**

This work consists of:

1. Within the roadway or trackbed section, trimming, shaping, and finishing ditches, slopes, and other graded surface areas to the lines, grades, typical sections or cross sections, as specified on the Contract Drawings, in these Specifications or by the Engineer.
2. Outside the roadway or trackbed section, obliterating roadways and other paved surfaces by loosening, breaking up, and spreading the existing base materials and surfaces lying outside the new roadway or trackbed cross section, and blending into the adjacent terrain.

PART II – PRODUCTS**2.1 WATER**

- A. Water used in the work shall be free of silts and other materials deleterious to the quality of the material to which it is applied or with which it is mixed.
- B. The Contractor shall make all necessary arrangements for obtaining water. The Contractor shall furnish, install and maintain equipment necessary to pump, haul and place the water. An adequate supply of water shall be maintained at all times.

PART III – EXECUTION**3.1 GENERAL**

- A. After the trackbed and roadway earthwork involved has been substantially completed, the following shall be performed:
 1. Ditches
 - a. Remove all litter, debris and obstructions.
 - b. Trim and shape to neat lines all ditches, channels, and canals provided for waterways.
 2. Slopes
 - a. Remove all exposed roots, debris, and all stones more than 3 inches in size which are loose or could become loosened.
 - b. Trim and shape all excavation and embankment side slopes. Shape tops of banks to circular curves with not more than two foot radius,

unless rock or right-of-way limitations makes such work impractical.

3. Structure Sites

- a. Clean out all sewers, culverts, drains, and their appurtenances constructed under the Contract.
- b. Remove all extraneous matter in the vicinity of culvert ends, inlets, walls, and other areas.
- c. Trim and shape the cleaned areas.

- B. Removed materials shall be disposed of as specified in Sections 02 41 00, 31 13 00, and 31 22 00.

3.2 HAUL ROAD

After the excavation removal work has been performed, remaining haul road bases and surfacings, within KCMO rights-of-way, shall be loosened by scarifying, plowing to a depth of at least 12 inches, or to solid rock, whichever is the lesser depth, and the loosened material shall be treated as follows:

- A. Break the loosened materials into fragments having no dimension greater than 3 inches, unless the aggregate in the original material exceeds that size.
- B. Remove the loosened and broken materials and deposit in a predetermined and suitable site designated to receive this kind of fill.

3.3 MAINTENANCE

The finished work shall be maintained in its finished condition until final completion of the work, or until it is covered with a subsequent course of material placed under the contract.

3.4 GRADING TOLERANCES

Roadways or trackbed finished surface of the aggregate base, and the surface of each underlying layer, shall parallel the design grade and cross-section for the finished surface within 0.07 foot. Grading tolerances for final asphalt, open graded and concrete pavement surfaces will be in accordance with Section 32 11 00, 32 12 16.10, and 32 13 13 respectively.

3.5 WATERING

Watering shall be performed at any hour of the day and on any day of the week necessary for proper performance of the work and for adequate alleviation of dust nuisance. Wastage of water or watering which is detrimental to other work shall be avoided and such operations ceased corrective measures shall be taken.

PART 4 - MEASUREMENT

- 4.1 **Measurement** – No Separate measurement will be made for Work described in this Section.

PART 5 - PAYMENT

- 5.1 **Payment** – No separate payment will be made for the Finish Grading. All costs pertaining thereto

shall be included in the Contract Unit Prices for other items as listed in the Bid Form-Unit Prices.

END OF SECTION

SECTION 31 23 00
BUILDING EXCAVATION, FILLING, AND BACKFILLING

PART 1 - GENERAL**1.1 SUMMARY**

- A. Furnish all labor, materials, tools, equipment, and services for Building Excavation, Filling, and Backfilling, as indicated, in accordance with provisions of Contract Documents.
- B. Definitions:
 - 1. Unsuitable material: Debris and/or soil material judged unsuitable by Geotech for support of slabs and foundations or for use as a fill or backfill material.
 - 2. Maximum density: As determined using ASTM-D698 (Standard Proctor).
 - 3. Geotech: Geotechnical Engineer or Representative of Foundation Consultant employed by Owner to inspect foundation work.
 - 4. Rock excavation: Excavation of rock material which is sufficiently solid and of such strength that it cannot be loosened or broken down in a single pass with following equipment:
 - a. Late model tractor mounted hydraulic ripper equipped with a single digging point sized for use with and propelled by a crawler type tractor rated at a minimum 200 net flywheel horsepower, operating in low gear.
 - b. A 0.6 cubic meter 3/4 cubic yard hydraulic backhoe with a rock tooth.
- C. Completely coordinate with work of other trades.

1.2 EXTRA WORK

- A. Removal and replacement of unsuitable material will be paid as extra work.
 - 1. Notify (Owner's agent) in time to estimate and record quantity removed.
 - 2. If Contractor is unwilling to accept estimate, notify Architect or Construction Manager prior to backfilling and a surveyor will be hired at Contractor's expense to measure and determine excavated volumes.
 - 3. Recorded quantity will be basis for payment.
 - 4. Include unit price on Bid Form.
- B. Rock excavation will be paid for as extra work.
 - 1. Notify (Owner's agent) in time to estimate and record quantity removed.
 - 2. Recorded quantity will be basis for payment.
 - 3. Include unit price on Bid Form.

1.3 QUALITY ASSURANCE

- A. Subsurface soils investigations have been made at project site.
 - 1. Soils information was obtained for use in preparing foundation design.
 - 2. Availability of soils report information is indicated in specifications.
 - 3. Examine site and soils report and independently determine character of materials to be encountered.
- B. Inspection and compaction density tests:
 - 1. Owner will hire the Geotech to inspect earthwork and to conduct in-place compaction moisture-density tests.
 - 2. Initial test at each location will be paid by Owner.
 - 3. If initial test fails, Contractor pays for retesting.
- C. Tolerances of subgrade:

1. 30 mm 0.10 FT plus/minus from required elevations.

1.4 SUBMITTALS

- A. Product Data:
 1. Maximum Density curves for fill and backfill material.
 2. Sieve analysis for granular fill.

1.5 JOB CONDITIONS

- A. Contractor is responsible for:
 1. Determining safe slopes of excavations for the earth materials encountered.
 2. Shoring and bracing excavations as required to protect personnel, utilities, existing construction and new work.
 3. Removing bracing when safe.
 4. Protecting from damage (or replacing as directed) sidewalks, pavements and other facilities resulting from settlement, lateral movement, undermining erosion or other hazards created by earthwork operations.
 5. Complying with rules and regulations governing earthwork and respective utilities.
 6. Providing adequate barricades and warning lights as required to protect persons and property and to satisfy applicable regulations.
 7. Maintaining bench marks, movements and other reference points and replacing any disturbed or destroyed.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Fill and backfill material:
 1. Clean selected materials, approved by Geotech, from site excavation or from off site borrow areas.
 2. Submit Maximum Density curves for each source of fill or backfill material.
- B. Granular fill:
 1. Clean, uncrushed, natural rounded gravel; without broken faces, sharp edges, or points.
 2. Submit sieve analysis verifying following gradation.
 - a. 100 percent passing 19 mm 3/4 IN sieve.
 - b. 100 percent retained on No.4 sieve (6 mm).

PART 3 - EXECUTION

3.1 EXCAVATION - GENERAL

- A. Do not perform blasting.
- B. Excavate to dimensions and elevations indicated regardless of materials encountered.
 1. Allow additional space as required for construction operations and inspection of foundations.
- C. Remove old foundations, building construction, and other materials concealed beneath present grade, as required to execute work, and as indicated.
- D. Remove and replace unsuitable material with compacted backfill as directed by Geotech.
- E. If rock is encountered, remove and replace with suitable material as directed by Geotech.

- F. Properly level off bottoms of excavations.
- G. Where cuts are required to bring floor slabs to proper elevations, excavate to level below slabs allowing for required granular fill.
 - 1. Remove rocks, lumps, vegetation and other foreign material.
 - 2. Scarify top 205 mm 8 IN of earth below granular fill and recompact to 95 percent of maximum density.
 - 3. Where compacted subgrade is disturbed by frost, moisture, or construction operations, re-scarify and recompact as directed by Geotech.
- H. Control grading around building.
 - 1. Pitch surface to prevent water from running into excavated areas or damaging structure.
 - 2. Maintain pits and trenches where footings will be placed free of water.
 - 3. Provide pumping required to keep excavated spaces clear of water during construction.
 - 4. When springs or running water are encountered, notify Architect. Provide free discharge of water by trenches or pumps, and drain to appropriate point of disposal as directed.

3.2 FOOTINGS AND PILE CAPS

- A. Provide undisturbed, level, dry, unfrozen surfaces free of foreign or loose material for placement of footings and pile caps.
- B. Obtain Geotech's approval of footing subgrade before placing concrete.
- C. Do not carry excavations lower than indicated, except when directed by Geotech.
- D. If excavations are made below indicated level, fill with concrete of same strength as foundation concrete at no extra cost.
- E. When excavations become soft and wet, remove soft material and replace with concrete of same strength as foundation concrete, at no extra cost.
- F. When freezing temperatures are expected, do not excavate to full depth unless footings or pile caps can be placed immediately. Protect bottoms of excavations from freezing if placement is delayed.

3.3 SUBGRADE PREPARATION, FILLING, AND BACKFILLING

- A. Remove rocks, lumps, frozen ground, soft or wet material, vegetation, and other foreign material upon which fill or backfill is to be placed.
- B. Before scarifying subgrade, obtain approval of Geotech.
- C. Scarify top 205 mm 8 IN of excavation surface or subgrade and compact to 95 percent of maximum density.
- D. Place fill material in 150 mm 8 IN lifts and compact each lift to 95 percent maximum density, 98% for wall footing support.
- E. Maintain moisture between 0 and 3 percent above optimum moisture content during compaction.
- F. Compact fill and backfill using suitable mechanical tamping equipment to obtain specified density.
 - 1. Use mechanical hand tampers for filling and backfilling next to walls.
 - 2. Compact granular fill using vibratory methods.
- G. Where existing ground surface is steeper than one vertical to four horizontal, step surface with steps not exceeding 305 mm 12 IN or slope surface not exceeding one vertical to 50 horizontal.

- H. Correct and recompact compacted material not meeting specified compaction requirements. Continue corrective measures until required compaction has been attained.
- I. Do not backfill against part of walls, piers, or columns until each part has reached design strength.
 - 1. Do not place fills against walls until floor slabs at top and bottom of walls are in place.
 - 2. Bring backfill up uniformly around building and individual wall units.
- J. Do not backfill against foundations, walls, curbs, footings, and areaways until concrete forms have been removed, masonry work has been pointed, and concrete finishing, dampproofing, and waterproofing have been completed.

3.4 GRADING NEXT TO BUILDING

- A. To provide drainage evenly slope finished grade away from building walls at slopes not less than one (1) vertical to fifty (50) horizontal.

3.5 GRANULAR FILL UNDER SLABS ON GRADE

- A. Place minimum 150 mm 6 IN granular fill below vapor retarder under slabs on grade.
 - 1. Vapor retarder: See Section 03 31 10.

3.6 ACCEPTANCE OF WORK

- A. Obtain Architect's and Geotech's approval of each earthwork operation before next operation.
- B. Notify Architect and Geotech in sufficient time for inspection.

3.7 DISPOSAL OF EXCESS AND WASTE MATERIAL

- A. Remove waste and excess materials including excess earth, unsuitable materials, trash and debris and legally dispose of it off Owner's property.

END OF SECTION

SECTION 31 23 13**SUBGRADE PREPARATION****PART 1 - GENERAL****1.01 SCOPE OF WORK**

- A. Furnish the necessary equipment, labor and materials required and perform all work in connection with the subgrade and roadbed construction as shown on the Drawings and as specified in American Public Works Association Standard Specifications and Design Criteria Section 2200 as revised, adopted, and provided by the Director of Kansas City, Missouri Public Works current at the time of bidding.

1.02 REFERENCE STANDARDS

- A. In addition to complying with all pertinent codes and regulations, comply with the referenced or applicable portions of the American Public Works Association Standard Specifications and Design Criteria as revised, adopted, and provided by the director of Kansas City, Missouri Public Works current at the time of bidding.
- B. The following standards are referenced directly in this section. The latest version of these standards shall be used.

ASTM D 698 -Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³))

ASTM D 2922 –Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

PART 2 - PRODUCTS (NOT USED)**PART 3 - EXECUTION****3.01 SUMMARY**

- A. This section includes subgrade preparation at locations which have been previously graded in accordance with the requirements of Section 31 22 00 entitled "Site Preparation and Grading."

3.02 DEFINITIONS**A. Subgrade**

1. Subgrade is defined as a well graded and compacted layer on which base and subsequent courses are placed.

B. Subgrade Preparation

1. Subgrade preparation is the repeated operation of fine-grading and compacting the subgrade until the specified lines, grades, and cross-section, as indicated on the plans are obtained and the materials are compacted to the specified depth and density.

3.03 CONSTRUCTION

A. General

1. The subgrade surface shall be brought to the specified lines, grades and cross-section by adding or removing material and compacting to the specified density. Tolerance allowed on all lines, grades and cross-sections shall be no more than 1/4 inch (6 mm).

B. Compacting the Subgrade

1. The top 6 inches (15.24 cm) of subgrade for pavements shall be compacted to 95% of the standard proctor maximum density for the material used as determined by ASTM D 698 and within a tolerance of plus 2% and minus 2% of the optimum moisture content.

C. Protection and Maintenance of Subgrade

1. The subgrade shall be protected from action of the elements or others. Any action (eg. settlement or erosion) that damages the subgrade or any subgrade that has become unacceptable prior to placing the pavement thereon, shall be repaired and the specific lines, grades, cross-section, tolerance, density, and moisture content range reestablished.
2. The Contractor shall protect all existing improvements from damage resulting from his subgrade operation. Any improvement damaged shall be repaired or replaced by the Contractor at his own expense.

D. Cleanup

1. Subgrade cleanup shall follow the work progressively. The Contractor shall remove from the project site all rubbish, surplus or discarded material, unsuitable material, and any equipment, tools and temporary construction items used for the preparation of the subgrade.

E. Roll Testing

1. Once the subgrade has been brought to the final plan elevation, but prior to approval of the subgrade for paving, all lanes shall be roll tested in their entire length. The subgrade will not be acceptable if rutting, pumping, or deformation of the subgrade results from the roll test. This testing will be done by the Contractor, and will be in addition to the applicable moisture and density testing, at no additional cost to the City or Engineer.
 - a. Equipment for roll testing shall be a tandem dump truck (one front and two rear axles) carrying a twenty ton load.

- b. The truck shall proceed slowly along each traffic lane, allowing the Inspector or Engineer to walk alongside and observe the results. Areas failing the roll test will be reworked and retested prior to approval of the subgrade for paving.

END OF SECTION 31 23 13

SECTION 31 23 16.16**STRUCTURAL EXCAVATION AND BACKFILL****PART I - GENERAL****1.1 SUMMARY**

- A. Description: This work includes performing excavation and furnishing and placing backfill, and shall be constructed in accordance with the specifications and in conformity with the lines, grades, dimensions and notes shown in the Contract Drawings and as specified herein.
1. Removal and disposal of materials for the construction of foundations for retaining walls, bridges piers, wayside buildings, box culverts, OCS poles and other structures as specified.
 2. Furnishing, placing, and compacting backfill materials for structures to the lines delineated and in areas that below the designed slope or subgrade line provided in the Contract Drawings.
 3. Unless otherwise specified, the work includes all equipment, machinery, tools, and incidentals required, including temporary dewatering and excavation support, for proper execution of the work.

1.2 REFERENCED STANDARDS

<u>Sponsor</u>	<u>Number</u>	<u>Subject</u>
AASHTO	M 145	Recommended Practices for Classification of Soils and Soil Aggregate Mixtures for Highway Construction Purposes
ASTM	C117	Materials Finer Than 75 μ m (No. 200) Sieve in Mineral Aggregates by Washing
ASTM	C 136	Sieve Analysis of Fine and Coarse Aggregates
ASTM	D 4318	Determining the Plastic Limit and Plasticity Index of Soils
AREMA		Manual of Railway Engineering
ASTM	D 1557	Soils and Soil-Aggregate Mixtures Using 10-lb Rammer and 18-in Drop

1.3 SUBMITTALS

- A. Submittals shall be made in accordance with the requirements of the Project Quality Plan, except as modified herein.
1. Submit method statement describing work sequence, steps, protection and remedial measures together with submittals of construction dewatering and sheeting, shoring and bracing.

1.4 QUALITY CONTROL

- A. Quality control shall be made in accordance with the requirements of the Project Quality Plan, except as modified herein.

PART II - PRODUCTS**2.1 MATERIALS****2.2 GRANULAR BACKFILL BORROW (STRUCTURAL FILL)**

- A. Classification A-1-a (AASHTO M 145) (GW, GP, SW, SP – ASTM)
- B. Non-plastic, uniformly graded with a particle size of 2" maximum.

PART III - EXECUTION**3.1 EXCAVATION**

- A. Perform clearing, grubbing, and removal within 6 ft outside of the structure exterior faces, unless otherwise shown on the Contract Drawings.
- B. Structural excavation shall be performed to the lines and grades as established within a tolerance of plus 0 inch or minus 2 inch.
- C. When piles are to be driven, complete the excavation for structures to the bottom of the footings before driving any piles within the excavation.
 - 1. Remove excess material remaining in the excavation after pile driving to the elevation of the bottom of the footings.
 - 2. When ground displacement results from pile driving operations, excavated or backfill the footing area to the grade of the bottom of the footing as shown on the Contract Drawings with structure backfill materials.
- D. Excavations shall be protected with shoring support or other means unless open excavation would not be contrary to applicable safety requirements or detrimental to adjacent structures, roadways, and railway tracks. Perform excavation support work in accordance with Section 31 41 00.
- E. When footing concrete is to rest upon rock, fully uncover the rock and remove the rock surface to a depth sufficient to expose sound rock using pavement breakers, rippers, backhoes, other excavation equipment, or non-explosive means that preclude breakage of rock materials below and outside of the structure excavation limits.
- F. Maintain excavated bottom dry and protect the bottom from water intrusion. Perform dewatering as required.
- G. Any unstable or unsuitable material below footing or base of structure, including bedding, shall be excavated until satisfactory foundation conditions are achieved. Replace the unstable or unsuitable material with competent material, such as concrete or structural fill to the foundation elevations as shown on the Contract Drawings.
- H. Foundations that will support structures shall be constructed as follows:

1. The top surface of backfilled foundations shall be constructed 3 ft beyond the boundary of the foundation, unless otherwise shown on the Contract Drawings. Granular Backfill Borrow shall be used and placed in 6 inch layers and compacted to not less than 90 percent of maximum density as determined by ASTM D 1557. Heavy compaction equipment shall not be allowed closer than 5 ft to embedded walls.
 2. The sides and bottom of the excavation shall not be disturbed. Concrete shall be placed against undisturbed soil where shown. Concrete may be used as backfill as permitted by the Engineer. If disturbed, all disturbed material shall be compacted to 95 percent of maximum density as determined by ASTM D 1557.
 3. Before placing concrete on rock foundations, all rock surfaces shall be cleaned and loose material removed; seams and fractures shall be cleaned and sealed with grout. Rock surface shall be leveled, stepped, or roughened as shown in the Contract Drawings.
- I. Notify the Engineer for inspection of the excavation when any structure excavation is completed. Place concrete into the excavation only after the excavation has been approved by the Engineer.

3.2 STRUCTURAL BACKFILL

- A. Backfilling and compaction shall be made in conformance with Section 31 22 00 for foundations of embankment or trench, or is to support a structure not covered in this Section.
- B. Do not place structural backfill until the structure footings or other portions of the structure to be backfilled have been inspected and approved for backfilling by the Engineer.
- C. Backfill shall not be placed so as to cause unbalanced loading on the concrete until the concrete has been in place 28 calendar days or until test cylinders show the concrete has attained 80% of design strength, whichever occurs first. Exceptions may be granted with Engineer's approval.
- D. Backfill shall be placed so as not to damage the concrete footings, drain pipes, and other permanent work. Backfill shall not be jetted or puddled. Perform compaction per Section 31 22 00.
- E. Flowable Fill may be used in place of structural backfill. See Section 03 90 00 for Flowable Fill specifications.

PART IV - MEASUREMENT

- 4.1 **Measurement** – No Separate measurement will be made for Work described in this Section.

PART V - PAYMENT

- 5.1 **Payment** – No separate payment will be made for structural excavation and backfill. All costs pertaining thereto shall be included in the Contract Unit Prices for other items as listed in the Bid Form-Unit Prices.

END OF SECTION

SECTION 31 23 33**TRENCHING, BACKFILLING, AND COMPACTING FOR UTILITIES****PART 1 - GENERAL****1.1 SUMMARY**

- A. Furnish all labor, materials, tools, equipment, and services for Trenching, Backfilling and Compacting for Utilities, as indicated, in accordance with provisions of Contract Documents.
- B. Definitions:
 - 1. Unsuitable material: Debris and/or soil material judged unsuitable by Engineer for support of slabs or other site improvements.
 - 2. Engineer: Soils Engineer employed by Owner and empowered to undertake necessary inspections and approvals.
 - 3. Rock excavation: Excavation of rock material which is sufficiently solid and of such strength that it cannot be loosened or broken down in a single pass with following equipment.
 - a. Late model tractor mounted hydraulic ripper equipped with single digging point sized to use with and propelled by crawler type tractor rated at a minimum 200 net flywheel horsepower, operating in low gear.
 - b. A 0.6 cubic meter 3/4 cubic yard hydraulic backhoe with a rock tooth.
- C. Completely coordinate with work of other trades.

1.2 EXTRA WORK

- A. Removal and replacement of unsuitable material will be paid for as extra work.
 - 1. Notify Owner's agent in time to have Engineer measure and record quantity removed.
 - 2. Recorded quantity will be basis for payment.
 - 3. Include unit price per cubic meter yard on Bid Form.
- B. Rock excavation will be paid for as extra work.
 - 1. Notify Owner's agent in time to have Engineer measure and record quantity removed.
 - 2. Recorded quantity will be basis for payment.
 - 3. Include unit price on Bid Form.

1.3 QUALITY ASSURANCE

- A. Compaction density test:
 - 1. Standard Proctor, ASTM-D698.
- B. Owner will hire an independent soils laboratory to conduct in place moisture and density tests.
 - 1. Contractor to pay for retests of material not passing initial tests.
 - 2. Notify Owner at least 2 weeks prior to anticipated date of testing.
 - 3. Contractor to pay additional costs if work is delayed due to Contractor's failure to notify party as specified above.
- C. Comply with aspects of "Safety Rules and Regulations for Excavation" as promulgated by State law for state in which excavation will occur.

2013/12/1331_23_33_hdr_TRENCHING, BACKFILLING AND COMPACTING FOR UTILITIES
(1).doc

1.4 JOB CONDITIONS

- A. Verify location and existence of underground utilities.
 - 1. Omission or inclusion of located utility items on drawings does not constitute non-existence or definite location.
 - 2. Secure and examine local utility surveyor records for available location data.
- B. Protect existing utilities from damage.
 - 1. Repair damages to utility items.
- C. Avoid overloading.
- D. Keep surcharge sufficient distance back from edge of excavation to prevent slides or caving.
- E. Maintain and trim excavated materials in such a manner to be as little inconvenience as possible to public and adjoining property owners.
- F. Provide full access to public and private premises, to fire hydrants, at street crossings, sidewalks and other points as designated by Engineer to prevent serious interruption of travel.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Backfill material:
 - 1. As approved by Engineer.
 - 2. Free of rock cobbles, roots, sod or other organic matter, and frozen material.
 - 3. Moisture content at time of placement:
 - a. Within 3 percent of optimum moisture content.
 - b. Wet dry material, as required.
 - c. Dry wet material, as required or:
 - d. Furnish off site material at no additional cost to Owner.

PART 3 - EXECUTION

3.1 GENERAL

- A. Remove and dispose materials Engineer finds unsuitable.
- B. Trench, backfill and compact for underground utilities.

3.2 TRENCH EXCAVATION

- A. Excavate trenches by open cut method to depth indicated and necessary to accommodate work.
 - 1. Permission may be granted for tunnel work for crossing under crosswalks, driveways or existing utility lines.
 - 2. Such tunnels are limited to 3050 mm 10 FT in length.
- B. Open no more than 90 m 300 LF of trench at one time, or less, as required by Engineer.
- C. Failure to comply may necessitate shutdown of entire project until backfilling is performed.
- D. Carry rock excavations minimum of 305 mm 12 IN below indicated invert elevations.
- E. Do not excavate below indicated grades unless required to remove unsuitable material.

(1).doc

F. Backfill overexcavations in maximum 205 mm 8 IN lifts compacted to specified density.

G. Trench size:

1. Excavate only sufficient width to accommodate free working space.
2. Cut trench walls vertically from bottom of trench to top of pipe, conduit, or utility service.
3. Trench width at top of pipe or conduit may not exceed outside diameter of utility service by more than following dimensions:

Overall Diameter of Utility Service	Excess Dimension
--	------------------

840 mm and less	400 mm
more than 840 mm	600 mm

Overall Diameter of Utility Service	Excess Dimension
--	------------------

33 IN and less	16 IN
more than 33 IN	24 IN

H. Keep trenches free of water.

I. Brace and sheet trenches as soil conditions dictate.

J. Do not remove until backfilling has progressed to a stage that no damage to piping, utility service, or conduit will result due to removal.

3.3 PREPARATION FOR PIPE LAYING

A. See drawings and specific pipe material sections for embedment requirements.

B. When discrepancy exists between those requirements and these specifications, provide type of embedment which provides greatest load factor.

C. Types of embedment:

1. Class A: Concrete cradle.
 - a. Load factors:
 - 1) 2.2 - Lightly Tamped.
 - 2) 2.8 - Carefully tamped.
 - 3) 3.4 - Reinforced Concrete with p=0.4 percent.
2. Class 4: Concrete arch type bedding.
 - a. Load factors:
 - 1) 2.8 - Plain Concrete.
 - 2) 3.4 - Reinforced Concrete with p=0.4 percent.
 - 3) 4.8 - Reinforced Concrete with p=1.0 percent.
3. Class B: First-class bedding.
 - a. Shaped bottom with tamped backfill, or:
 - b. Compacted granular bedding with tamped backfill.
 - c. Load factor:
 - 1) 1.9 - Carefully compacted backfill.
4. Class C: Ordinary bedding.
 - a. Granular bedding with tamped backfill.
 - b. Load factor:
 - 1) 1.5 - Lightly compacted backfill.

D. Form bell holes in trenches such that only barrel of pipe is firmly supported by bedding material.

2013/12/1331_23_33_hdr_TRENCHING, BACKFILLING AND COMPACTING FOR UTILITIES
(1).doc

3.4 BACKFILLING

- A. Do not backfill until tests are performed on system, and system complies with specified requirements.
- B. Hand or pneumatic tamp backfill around and over pipe in lifts not exceeding 205 mm 8 IN loose thickness.
- C. Compact to specified density.
- D. Exercise care in backfilling operations to avoid displacing pipe joints either horizontally or vertically and to avoid breaking pipe.
- E. Do not water flush or puddle to consolidate backfill.

3.5 COMPACTION

- A. Compact trench backfill in areas under paved roads, parking areas, sidewalks and other structures as directed by Engineer to at least 95 percent of maximum dry density.
- B. In locations where trench will not be under paved areas, compact backfill to minimum 90 percent of maximum dry density.

3.6 CLEANUP

- A. Cleanup debris resulting from work.

END OF SECTION

SECTION 31 25 00**EROSION AND SEDIMENTATION CONTROLS****PART I - GENERAL****1.1 SUMMARY****A. Description**

1. The Contractor shall prepare and submit an Erosion Control Plan (ECP) which satisfies the requirements of this section as described below.
2. This work consists of temporary control measures as shown on the Erosion Control Plans [SWPPP] or ordered by the Engineer during the life of the contract to control water pollution and soil erosion through the use of berms, dikes, swales, dams, fiber mats, netting, gravel, mulches, grasses, slope drains, sediment fences, and other sediment barriers, gravel construction entrances, and other erosion control devices or methods.
3. This work also consists of temporary and permanent in-stream erosion control measures as shown on the Erosion Control Plans or ordered by the Engineer during the life of the contract to control turbidity in waterways through the use of berms, sandbag dikes, riprapped ditch outfalls, swales, cofferdams, filter fabric, fiber mats, riprap, temporary stream diversion and other erosion control devices or methods.
4. Temporary pollution control provisions contained herein shall be coordinated with any and all permanent erosion control features specified elsewhere in the Contract to the extent practicable to assure economical, effective, and continuous erosion control throughout the construction and post-construction period.
5. Failure to control erosion or pollution shall be cause for the Engineer to stop construction work in the vicinity of the erosion breach, until measures have been taken to bring construction into compliance with this Section.

B. Related Sections

1. 31 22 00 – Site Preparation and Grading
2. 31 22 19 - Finish Grading
3. 32 11 00 - Aggregate Base Course
4. 31 05 19.13 - Geotextile Fabric, Geocomposites and Ballast Mats

1.2 REFERENCES

<u>Sponsor</u>	<u>Number</u>	<u>Subject</u>
USA	(latest edition)	Erosion Control Plans Technical Guidance Handbook

1.3 SUBMITTALS

- A. Submittals shall be made in accordance with the requirements of the Project Quality Plan, except as modified herein.
- B. The Contractor shall submit an Erosion Control Plan. The Erosion Control Plan shall include the methods of operation and the schedules for accomplishing temporary and permanent erosion control work and work required, as are applicable for clearing and grubbing, grading, trenching, bridges, and other structures at water-courses, paving, and other construction. The Erosion Control Plan shall also include a proposed method of erosion control on haul roads and borrow pits and a plan for disposal of waste materials. No work shall be started until the Erosion Control Plan has been reviewed by the Engineer and found to comply with the requirements of the Plans and Specifications. The approved Erosion Control Plan and schedule shall be subject to Engineer-approved modifications during construction.
- C. Working drawings and data shall be submitted on proposed silt fences and other geotextiles, including physical properties of geotextile fabric.
- D. The Contractor shall submit methods of in-stream erosion control to the Engineer for review and approval before work in a waterway site is initiated.
- E. Proof of seeding specification, see Storm Water Pollution Prevention Plan, section 2.3.1.
 - 1. Seeding material shall be purchased just prior to seeding season.
 - 2. Proof of purchase shall be available for review by Engineer during construction. Proof shall constitute copies of purchase orders and written confirmation of receipt and acceptance of order by Supplier.
- F. The following shall be submitted 14 days prior to acceptance:
 - 1. Schedule for maintenance work as specified herein.
 - 2. "As-Built" drawings for landscape work.
- G. The following shall be submitted as requested:
 - 1. Delivery tickets, receipts, materials, packages, and other items as requested by Engineer to verify amount and type of materials supplied.
 - 2. Other items as requested by Engineer to verify compliance with Contract requirements.

1.4 QUALITY ASSURANCE

- A. In the event of conflict between these requirements and pollution control laws, rules, or regulations of other federal, state or local agencies, the more restrictive laws, rules, or regulations shall apply.
- B. Fertilizers shall conform to all state and federal regulations and shall be subject to testing by the Engineer.
- C. Seed shall be tested within 9 months of the delivery date and shall not be sprouted, moldy, or show evidence of having been wet or otherwise damaged. Each lot of seed

shall be subject to inspection, sampling, and testing upon delivery to the Project. Seed that is not labeled or that does not conform to Specifications will be rejected.

- D. Contractor shall comply with the Storm Water Pollution Prevention Plan that contains seeding specifications.
- E. Contractor shall notify Engineer 24 hours in advance of intent to hydro-seed.
- F. Engineer or his representative shall be present at the time when the materials are being assembled for the hydro-seeding process to insure that the proper materials and quantities are present at the specified rates as herein specified.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Packing and Shipping: Packed materials shall be delivered in original unopened containers showing weight, analysis and make of manufacturer. Materials shall be protected from damage and deterioration during delivery and while stored at site.
- B. Any required geotextile shall be delivered, handled and stored in accordance with the recommendations of the manufacturer and as specified in Section 31 05 19.13.

1.6 PROJECT CONDITIONS

A. General

- 1. The Engineer has the authority to limit the surface area of erodible earth material exposed by clearing, grubbing, excavation, borrow, embankment, and fill operations, and to direct the Contractor to provide immediate, permanent, or temporary pollution control measures to prevent contamination of adjacent streams or other watercourses, lakes, ponds, or other areas of water impoundment. Such work may involve the construction of temporary berms, dikes, dams, sediment basins, slope drains, and use of temporary mulches, mats, seeding, or other control devices or methods as necessary to control erosion. Cut slopes shall be seeded and mulched as the excavation proceeds to the extent considered desirable and practicable by the Engineer.
- 2. The ECP facilities shall be constructed in conjunction with all clearing, grading, and other land alteration activities, and in such a manner as to ensure that sediment laden water does not enter the drainage systems, or violate applicable water quality standards.
- 3. The ECP facilities in the approved Erosion Control Plan shall be upgraded as needed during the construction period for unexpected storm events or for other reasons to ensure that sediment laden water does not leave the construction site.

B. Permanent Features

- 1. All permanent erosion control features shall be incorporated into the Project at the earliest practicable time as outlined in the Contractor's accepted schedule. Temporary pollution control measures shall be used to correct conditions that develop during construction that were not foreseen during the design stage, that are needed prior to installation of permanent pollution control features, or to temporarily control erosion that develops during normal construction.
- 2. Where erosion is likely to be a problem during clearing and grubbing operations, work shall be scheduled and performed so that grading operations and

permanent erosion control features can follow immediately thereafter if the Project conditions permit; otherwise temporary erosion control measures shall be required between successive construction stages.

C. Areas of Work

1. The Engineer will limit the area of clearing, grubbing, excavation, borrow, and embankment operations in progress commensurate with the Contractor's capability and progress in accordance with the Contractor's submitted schedule and based upon construction conditions. Should seasonal limitations make such coordination of operations unrealistic, temporary erosion control measures shall be taken immediately.
2. The boundaries of the clearing limits will be clearly flagged by the Engineer upon request prior to construction. Disturbance of the ground will not be permitted beyond the flagged boundary. The flagging shall be maintained for the duration of the construction.
3. Temporary soil erosion and sediment control may include construction work outside the right-of-way where such work is necessary as a result of project construction such as borrow pit operations, haul roads, and equipment storage sites.

D. Maintenance and Removal

1. The erosion control features installed shall be acceptably maintained, including replacement and upgrading of the facilities when needed, until the project is completed and notice of final acceptance issued.
2. The ECP facilities on active construction sites shall be inspected daily and repaired as necessary to ensure their continued functioning. Inactive sites shall be inspected at least monthly, but inactive and active sites shall be inspected at least daily during rainy periods. Deficiencies shall be corrected immediately.
3. Catch basins (inlets with sumps or inverted siphons) shall be maintained so that not more than one-foot sediment shall be allowed to accumulate within a trap (or sump). All catch basins and storm drains shall be cleaned prior to paving and prior to project acceptance. The sediment shall be removed and sediment laden water shall not be flushed into the downstream system.
4. All paved areas shall be kept clean for the duration of the Project. Additional measures to those shown on the Plans may be required.
5. At no time shall more than a one-foot depth of sediment be allowed to accumulate behind a silt fence. Sediment shall be removed or regraded into slopes, and the silt fences repaired and reestablished as needed.
6. Silt fences shall be removed in their entirety when no longer required. They shall be required until the uphill area has been permanently stabilized.
7. All pipes, end sections, drainage curbs, silt fences, and other materials which are removed from temporary erosion control devices and not incorporated into the permanent work and shall be removed from the area. Materials shall be disposed of in accordance with federal, state and local laws and in a suitable location.

1.7 WARRANTY:

- A. The contractor shall be responsible for the protection, watering and replacement of any seeded areas until acceptance by the Engineer.
- B. This guarantee shall include re-seeding of any areas, repairing of any eroded places and maintaining the seeded areas by watering and controlling of insects as well as advising the owner of any maintenance or watering procedures necessary to care for and promote seed germination and growth.
- C. All seeded areas must be in satisfactory condition at the time of the final inspection.

PART II- PRODUCTS

2.1 SEED MIXTURE – Refer to Storm Water Pollution Prevention Plan.

2.2 MATTING

- A. Jute Matting
 - 1. Jute matting shall consist of a uniform, open, plain weave of single jute yarn. The yarn shall be of loosely-twisted construction and shall not vary in thickness by more than one-half of its normal diameter. The weave shall provide openings of about one square inch.
 - 2. The matting shall be furnished in widths of 45 inches or more, continuous lengths of not less than 150 feet, and weight not less than 0.9 pounds per square yard.
 - 3. Staples shall be made of 12 gauge or heavier steel wire which is bent to a U-shape 2 inches wide. Staples shall not be less than 10 inches long unless the Engineer allows a shorter length for hardpan soil conditions.
 - 4. Installation will be done in accordance with manufacturer's recommendations.
- B. Excelsior Matting
 - 1. Excelsior matting shall consist of a machine-produced blanket of curled-wood fibers, of which 80 percent are 6 inches or longer. Blanket shall be uniform thickness, with the fiber evenly distributed over the entire area of the mat.
 - 2. The top side of the matting shall have a maximum 3 inch x 3 inch size mesh of high wet-strength, twisted kraft paper, or a maximum 2 inch x 2 inch biodegradable, extended plastic mesh. The matting shall be smolder-resistant without the use of chemical additives.
 - 3. Excelsior matting shall have a minimum dry weight of 0.8 pound per square yard, and furnished in minimum 36-inch wide rolls.
- C. Coconut Matting
 - 1. Coconut matting shall consist of a machine-produced mat containing a matrix of coconut fibers. Blanket shall be uniform thickness, with the coconut fiber evenly distributed over the entire area of the mat.
 - 2. The matting shall be contained by a polypropylene netting having ultraviolet additives to resist breakdown. It should biodegrade after 24 - 36 months. The matting shall be smolder-resistant without the use of chemical additives.

3. Coconut matting shall have a minimum dry weight of 0.5 pound per square yard.

2.3 GEOTEXTILES

Geotextiles shall conform to the requirements of Section 31 05 19.13.

2.4 MISCELLANEOUS MATERIALS

- A. Plastic Sheeting: Plastic sheeting shall be clear polyethylene plastic at least 10 mils thick.
- B. Temporary Drainage Curbs: Temporary drainage curbs shall be machine extruded asphalt concrete or Portland cement concrete.
- C. Silt Fences: Silt fences shall be constructed of geotextile drainage fabric supported on wood or metal posts. Geotextile materials shall be as specified in Section 31 05 19.13.
- D. Aggregate: Aggregate for soil erosion and sediment control facilities shall conform to Section 32 11 00, Paragraph 2.1.B, Grading Requirements for 1-¹/₂-inch grading.
- E. Riprap: Material shall be as specified in section 31 37 00.
- F. Compost: Compost shall be of clean mixed yard debris, ³/₄ inch minus particle size. It shall be stabilized and mature with less than 25 percent moisture content and less than 5 percent foreign materials (rock, glass, etc.), including less than 2 percent plastics, by weigh

PART III - EXECUTION

3.1 EROSION CONTROL SEEDING

- A. General
 1. The work shall be performed only when local weather and other conditions are favorable to seeding. The work shall not be performed when wind velocities would prevent uniform application of materials or would drift materials.
 2. Seeding shall be performed in stages along the project as soon as practical after completing earthwork.
- B. Preparation of Areas
 1. All earthwork shall be completed before seeding. Areas which are misshapen or eroded shall be restored before seeding.
 2. Rocks, weeds, debris and other matter detrimental or toxic to the growth of grass shall be removed from areas to be seeded. If topsoil is to be added to these areas, existing ground surface shall be cultivated to a depth of 4 to 6 inches before placing topsoil. All loose stones larger than 2 inches, on 3:1 or flatter slopes shall be removed.
 3. Existing vegetation that is to be left in place shall not be damaged.

4. On areas to be seeded surface soil shall be prepared to a condition favorable for germination of seed and growth of grass. At least 2 inch of surface shall be maintained in a loose condition.
5. Surface preparation operations shall be performed along the contours of areas involved. On cut and fill slopes, minor ridges and irregularities shall be formed to retard erosion and improve germination.

C. Seeding

1. General

- a. The Engineer shall be given at least 2 days notice in advance of seeding and shall be kept advised of continuing operations.
- b. Seed shall be prevented from falling or drifting onto areas occupied by rock base, rock shoulders, plant beds or other areas where grass is detrimental.

2. Seeding Method

- a. The area to be seeded shall be staked in 2000 square foot segments to control application rates and verify coverage.
- b. Combine the specified seed mixture at the rates herein specified; fertilizer at the rate of 6 pounds per 1000 s.f.; "silva-fibre" at the rate of 2000 pounds per acre; seeds at the specified seeding rates for the variety of seed being applied and water in tanks. Agitate these components into a well mixed slurry suspension. Spray the mixture under pressure onto the prepared areas to be seeded.
- c. This seeding shall be accomplished in the early spring prior to April 15 or in the fall after September 1 and no later than October 15. The preferred time for seeding is in the fall.
- d. Regardless of equipment and methods used, drift and displacement of seed and fertilizer shall be prevented. If equipment and methods of application results in wasting material, corrections shall be made as directed. Areas previously completed shall not be disturbed. If areas are disturbed they shall be redone as directed.

D. Watering

1. Watering of the seeded areas shall be the complete responsibility of the Contractor by whatever means necessary to establish the seed in an acceptable manner prior to acceptance by the Engineer. If an irrigation system is in place on the site, but if for whatever reason, water is not available in the system, it is the full responsibility of the Contractor to water the seeded areas by whatever means, until the area is accepted by the Engineer.
2. Erosion caused by over watering shall be repaired immediately and re-seeded according to these specifications.
3. Areas that continually experience erosion shall be sodded.

3.2 MATTING

- A. Jute, Excelsior or coconut matting shall be placed flat in single thickness strips paralleling the direction of probable water flow.
- B. Multiple strips of jute or coconut matting shall be lapped in shingle fashion in accordance with manufacturer's recommendations.
- C. Overlapping of adjacent strips of Excelsior matting will not be required. Matting shall be in contact with the soil at all points and secured with staples.

3.3 PLASTIC SHEET

- A. Plastic sheet covering shall provide immediate erosion protection to slopes and disturbed areas when vegetative cover cannot be achieved due to soils, slopes, or time of year.
- B. Plastic sheet covering shall be used:
 - 1. On disturbed areas which require immediate erosion protection.
 - 2. On areas of steep slopes (greater than 50 percent) and areas of moderate slopes that are prone to erosion, particularly during wet weather season (October 1 through May 31).
 - 3. As a temporary measure to provide erosion protection and assist in germination on areas seeded between November 1 and March 31.
 - 4. With sandbag dikes to make temporary cofferdams at structures.
- C. Covering shall be installed and maintained tightly in place by using sandbags or tires on ropes with a maximum 10 foot grid spacing in all directions. All seams shall be taped or weighted down full length and there shall be at least a 12 inch overlap of all seams. For seams parallel to the slope contour, the uphill sheet shall overlap the downhill sheet.
- D. Drainage from areas covered by plastic sheeting shall be controlled such that no discharge occurs directly onto uncontrolled, disturbed areas of the construction site.
- E. Plastic sheeting shall be installed immediately on areas seeded between November 1 and March 31, and remain until vegetation is firmly established.
- F. When the plastic sheeting is used on unseeded slopes, it shall be left in place until the next seeding period.

3.4 STORM DRAIN INLET PROTECTION

- A. Storm drain inlet protection shall prevent sediment from entering storm drain systems prior to permanent stabilization of disturbed areas.
- B. Storm drain inlet protection shall be used:
 - 1. Where storm drain inlets are operational before permanent stabilization of the disturbed drainage area.
 - 2. Adjacent to and immediately downhill of utility type construction in existing paved areas with catch basin drainage.
 - 3. When cleaning streets.

- C. Berms may be required to direct drainage to flow through the filters and prevent bypassing of the inlets.
- D. At no time shall more than a one-foot depth of sediment be allowed to accumulate against storm drain inlet protection. Sediment shall be removed and inlet protection restored as needed to maintain the sediment trapping and filtering capability.

3.5 TEMPORARY EROSION BLANKETS

- A. Temporary erosion blankets shall provide immediate protection and physical stabilization of disturbed soils. Typically they are used when vegetative cover cannot be achieved due to soils, slopes, or time of year. Temporary erosion blankets may be used to enhance success of seeding, planting, or sodding.
- B. Temporary erosion blankets shall be used on areas of steep slopes (greater than 50 percent) and areas of moderate slopes that are prone to erosion, particularly during wet weather season (October 1 through May 31).
- C. Erosion blankets may be used on level areas and on slopes up to 1:1. Where soil is highly erodible, netting shall only be used in conjunction with an organic mulch such as straw and wood fiber. The blanket shall be applied so that it is in complete contact with the soil; if it is not, erosion will occur beneath it. Erosion blankets shall be securely anchored to the slope in accordance with manufacturer's recommendations.
- D. Excelsior blankets are considered protective mulches and may be used alone on erodible soils and during any time of year.

3.6 TEMPORARY SILT FENCES

- A. Temporary silt fence shall reduce the transport of sediment from a construction site by providing a temporary physical barrier to sediment and reducing runoff velocities. The terms "filter fabric" and "geotextile" are used interchangeably herein. Silt fences shall not be installed across streams.
- B. Temporary silt fences shall be constructed:
 - 1. Down the slope below disturbed areas where runoff may occur as sheet runoff.
 - 2. At the toe of soil stockpiles.
 - 3. At grade breaks exceeding 20 percent.
 - 4. Following discharge from a sediment trap or pond.
- C. Silt fences shall be constructed along the contours where feasible.
- D. In the event that the Contractor elects to construct fence of geotextile and wire fabric, the geotextile shall be a continuous roll cut to the length of the barrier to avoid use of joints. When joints are necessary, geotextile shall be spliced together only at support posts, with a minimum 6 inch overlap, and both ends securely fastened to the post.
- E. The geotextile shall be fastened securely to the uphill side of the wire mesh (if used) and posts. The geotextile shall extend into a trench, excavated on the uphill side of the posts, 6 inches vertically and 6 inches horizontally.

- F. The geotextile shall not extend more than 30 inches above the original ground surface.
- G. Geotextile shall not be stapled to trees.
- H. When extra-strength geotextile and closer post spacing are used, the wire mesh support fence may be eliminated.
- I. Manufactured sediment control fences shall be installed in accordance with manufacturer's recommendations.

3.7 TEMPORARY SLOPE DRAINS

- A. Temporary slope drains shall consist of a waterproof drainage structure to carry surface water down embankment slopes with a minimum of erosion. The drains may be of plastic or metal materials as the Contractor elects except the end section, pipe stub, and elbow sections at the top of each slope drain shall be 12-inch minimum diameter metal.
- B. Temporary slope drains shall be extended along the embankment as the height of the embankment increases. Water shall be directed into the drains by means of temporary earth berms at the top of the embankment slopes. Temporary drainage curbs shall be installed on the stage construction surface to direct water to the temporary drains until construction of the permanent drainage structures are completed at which time the temporary drainage curb and the temporary slope drains shall be removed.

3.8 GRAVEL CONSTRUCTION ENTRANCES

- A. Reduce the amount of mud, dirt, rocks, and other matter transported onto roads by motor vehicles or storm water runoff by constructing a stabilized pad of gravel at entrances and exits to construction sites.
- B. Gravel construction entrances shall be constructed at all construction sites at the point where traffic will be leaving the site and moving directly onto public roads, other paved areas, or other approved access points. A geotextile shall be placed under all gravel.
- C. Aggregate shall be clean pit run gravel approved by the Engineer or aggregate as set forth in Section 32 11 00. Subgrade geotextile shall meet the requirements of Section 31 05 19.13.
- D. Gravel pad shall be at least 8 inches thick and 50 feet in length. Width shall be the full width of the vehicle ingress and egress area. Gravel shall be added periodically as needed to maintain proper function of the pad.
- E. If the gravel pad does not adequately remove dirt and mud from vehicle wheels such that mud and dirt tracking is evident off site, additional measures shall be taken. Such measures may include hosing off wheels before vehicles leave the site or other construction techniques or work operation modifications. Wheel washing shall be done on the gravel pad and wash water shall drain through a silt-trapping structure prior to leaving the construction site.

3.9 IN-STREAM EROSION CONTROL

- A. Contractor shall implement in-stream erosion control measures to prevent stream bank erosion, scour and turbidity in the waterways to minimize unwanted sedimentation and disruption of wildlife habitat. Contractor's operations shall be executed to comply with all

current requirements for in-stream erosion control as dictated by the Federal, State and local agencies having jurisdiction over the waterway.

- B. Work in waterways is restricted by the Corps of Engineers Nationwide 404 Permit to the annual period between July 1 and September 30. This period may be shortened by the above agencies if weather conditions dictate. The Contractor shall be prepared to cease in-stream operations upon notice from the Engineer.
- C. The Contractor shall submit methods of in-stream erosion control to the Engineer for review and approval before work in a waterway site is initiated. The in-stream erosion control method offered by the Contractor must be approved by the respective Federal, State and local jurisdictions before submittal to the Engineer for approval. The in-stream erosion control method shall conform to the following:
 - 1. All grading, excavating, clearing and grubbing, stripping, backfilling, pile driving, forming, and placing concrete shall only be permitted in areas that are isolated from the waterway. Acceptable methods for isolating the waterway are sandbag dikes or a temporary cofferdam to an elevation 1'-6" above the expected water elevation during the time of construction. Use of berms to divert the stream shall be designed, and reviewed by the respective federal, state and local jurisdiction, on a site specific basis to insure turbidity control during construction and removal. A flowing stream such as a creek or drainage ditch may be contained in pipe sized for expected flows or trapped and pumped around the worksite by equipment sized for expected flows.
 - 2. Any water seeping into an excavated area which interferes with the work shall be removed by pumping into a facility designed to remove turbidity from the water before it is returned to the stream. An established grassy swale with bio-bags filtering the concentrated flow is an acceptable method of removing fine suspended particulate matter from the excess seepage water. An adequately sized settlement pond is also acceptable.
 - 3. All in-stream areas regraded by cutting shall be treated to prevent erosion of the freshly cut bank. Below Mean Low Water level, the slope shall be over excavated, covered with riprap geotextile fabric, and covered with Class 50 Riprap. Above Mean Low Water level, to the top of the stream bank, the slope shall be covered by a biodegradable erosion control mat, held in place as per manufacturer's recommendations. The mat shall resist biodegrading for 2 years.
 - 4. All in-stream areas to be backfilled shall be protected with Class 100 Riprap placed a minimum 2'-0" thick over riprap geotextile fabric. The finish grade shall be at top of riprap.

3.10 CLEAN-UP

- A. The contractor shall keep the site free from accumulation of waste material.
- B. At the time of completion, all areas must be swept or washed clean and all rubbish removed.

PART 4 - MEASUREMENT

- 4.1 **Measurement** – No Separate measurement will be made for Work described in this Section.

PART 5 - PAYMENT

5.1 Payment – No separate payment will be made for erosion and sedimentation controls. All costs pertaining thereto shall be included in the Contract Unit Prices for other items as listed in the Bid Form-Unit Prices.

END OF SECTION

SECTION 31 34 19**GEOSYNTHETIC REINFORCED SOIL SLOPE SYSTEM****PART 1 - GENERAL****1.1 DESCRIPTION**

Work shall consist of design, furnishing materials, and construction of geosynthetic reinforced soil slope (GRSS) structure meeting approval of the Engineer. Design and supply of geosynthetic reinforcement, drainage composite, and erosion control materials, and site assistance are all to be furnished by the slope system supplier.

1.2 PREQUALIFICATION OF REINFORCED SLOPE SYSTEM AND MATERIALS.

All systems and materials shall be pre-qualified and approved before the contract is awarded. To apply for prequalification or prequalification requirements, the supplier or manufacturer shall submit a request to Construction and Materials. The following systems are pre-qualified and may be used:

Tensor Sierra Slope Retention System:

Tensor Earth Technologies, Inc.	Phone 404-250-1290
5883 Glenridge Drive	sales 800-202-4459
Suite 200	fax 404-250-0461
Atlanta, GA 30328-5363	

Mirafi Geogrid Reinforced Slope:

Ten Cate Nicolon USA	Phone 706-693-2226
365 South Holland Drive	fax 706-693-4400
Pendergrass, GA 30567	email: tc mirafi@rtcusa.net

StrataSlope System:

Strata Systems Inc.	Phone 770-888-6688
380 Dahlonega Rd, Suite 200	fax 770-888-6680
Cumming, GA 30040	email: strata@geogrid.com

1.3 PRELIMINARY DESIGN AND PLANS.

- A. Prior to any work being done, GRSS design plans and computations shall be submitted to the engineer complete with all details as a separate submittal for each individual reinforced slope structure.
- B. All drawings shall be clear and complete. Six sets of drawings of the completed wall design plans shall be submitted for distribution. The drawings submitted shall be legible and have distinct details of sufficient contrast to be suitable for microfilming. Drawings which do not have the desired clarity and contrast will be returned for corrective action. The GRSS system manufacturer shall be solely responsible for the content of the design plans.
- C. All GRSS design plans submitted for distribution shall be signed, sealed and stamped in accordance with the laws relating to architects and professional engineers (Chapter 327, RSMo.).
- D. The minimum factors of safety for slope stability shall be as follows or as required by the

contract.

1. 1.5 against horizontal sliding of the reinforced mass along its base
 2. 1.3 against external, deep seated failures
 3. 1.3 against compound failure surfaces
 4. 1.3 against internal failure
 5. 1.1 seismic loading for the above failure modes
- E. Reinforced slopes shall be designed for the appropriate SEISMIC PERFORMANCE CATEGORY A, B, C, or D and additional requirements as may be shown in the plans or this specification.
- F. Completed GRSS design plans shall also contain all material specifications, fabrication requirements, and all construction requirements for erecting the reinforced slope complete in place. Any requirements on the design plans conflicting with this special provision shall not be used.
- G. The effect of construction damage test shall be incorporated into the construction damage factor F_c that is applied to the limit and serviceability state reinforcement tensions. Where construction tests have been made, but with fills or construction procedures other than those representative or site specific on the project, the minimum value of F_c shall be taken as 1.25. Lower values of F_c may be only used if substantiated with damage test using fills and construction procedures specific to the project. A default F_c value of 3.0 shall be used in the absence of any construction tests.

1.4 BACKFILL MATERIAL.

- A. Backfill material for GRSS shall conform to the following requirements.
- B. Backfill shall be gravel, stone, sand or any combination, conforming to the following gradation limits:

Sieve Size	Percent Passing
3/4 inch (19 mm)	100-75
No. 4 (4.75 mm)	100-20
No. 40 (425 μ m)	0-60
No. 200 (75 μ m)	0-50

- C. The plasticity Index, as determined by AASHTO T-90, shall not exceed 20.
- D. The material shall substantially be free of shale or other soft, poor durability particles and shall have a magnesium sulfate soundness loss of less than 30 percent after four cycles as determined by AASHTO T-104.
- E. Backfill materials shall meet the following electrochemical requirements:

Requirements	Test Methods
pH 4.5-9.5	California DOT 643
Organic Content < 1%	California DOT 643
Chlorides < 100 ppm	California DOT 422
Sulfates < 200 ppm	California DOT 417

- F. The contractor shall furnish to the engineer a Certificate of Compliance certifying the selected granular backfill material complies with this section of the specifications. A copy of test results from an approved laboratory testing the material for all of the above requirements shall also be furnished to the Engineer. Tests shall apply specifically to the material being used and shall not be more than twelve months old, if previously tested for another job and still applicable.
- G. Acceptance will be based on the Certificate of Compliance, accompanying test reports, and any applicable tests performed by the Engineer.

1.5 DESIGN AND PLAN REQUIREMENTS.

- A. The final design to be submitted after contract award shall include detailed design computations and all details, dimensions, quantities and cross sections necessary to construct the slope(s). The fully detailed plans shall be prepared to KCMO standards and shall include, but not be limited to, the following items:
1. An elevation view indicating elevations at top and bottom of slope, beginning and end stations, all horizontal and vertical break points, whole station points, and each level of reinforcement. Location of proposed final ground lines shall be indicated.
 2. Length, size, and type of grade of reinforcement shall be shown.
 3. Internal drainage alignment, elevations, and slope face exit points shall be shown on the elevation, plan, and cross section views.
 4. Plan view shall reflect the horizontal alignment and shall indicate the offset from the horizontal control line to the front face of the slope. All utilities, signs, lights, etc. that affect the reinforced slope shall be shown.
 5. Any general notes required for construction of the reinforced slope.
 6. Cross sections showing limits of construction fill requirements, and excavations limits.
 7. Limits and extent of reinforced soil fill volume.
- B. Typical Details of Primary and Secondary Reinforcement.
1. Facing details for erosion control.
 2. Temporary slope face support (if required).
 3. All details for construction of slope around drainage facilities, overhead sign footings and abutments shall be clearly shown.
- C. Detailed Design Computations.

1. Slope stability computations, computer output, and an explanation of analysis details within the program. If an in-house computer program was used, submit a copy of the computer program with user documentation .
 2. Cross section plots showing critical failure planes for internal, compound, and global failure modes; and a summary of the critical failure surface(s) search.
 3. Sliding stability computations.
 4. Seismic stability computations, where applicable.
 5. Tractive shear stress of all erodible surfaces and appropriate anchorage mechanism(s). (Erosion protection requirements per KCMO specification)
 6. Drainage system design computations including volume of water to be removed by the subsurface drainage system; geotextile retention, permeability, and survivability requirements based upon fill and subgrade characteristics; and maximum long-term flow of the drainage composite. (Maximum drain spacing and flow requirements per KCMO specification)
- D. The plans and design computations shall be prepared and sealed by a professional engineer, licensed according to Chapter 327. RSMo. Six sets of design drawings and detail design computations shall be submitted to the Engineer. The computations shall include a detailed explanation of any symbols and computer programs used in the design. All design and construction details will be checked by the Engineer against the preapproved design values and procedures for materials approved for use in that particular system.

1.6 CONSTRUCTION REQUIREMENTS.

- A. Delivery, storage, and handling of geosynthetic reinforcement, drainage composite, and geosynthetic erosion mat shall comply with requirements set forth in the Missouri Standards Specifications for Highway Construction.
- B. Geosynthetic reinforcement material suppliers shall provide a qualified and experienced representative on site, for a minimum of three days, to assist the contractor and KCMO inspectors at the start of construction. If there is more than one slope on a project, then criteria will apply to construction of the initial slope only. The representative shall also be available on an as needed basis, as requested by the Engineer, during construction of the remaining slope(s).
- C. All areas immediately beneath the installation area for the geosynthetic reinforcement shall be properly prepared as detailed on the plans, specified elsewhere within the specifications, or directed by the Engineer. Subgrade surface shall be level, free from deleterious materials, loose or otherwise unsuitable soils. Prior to placement of geosynthetic reinforcement, subgrade shall be proof-rolled to provide a uniform and firm surface. Any soft areas, as determined by the Engineer, shall be excavated and replaced with suitable compacted materials. Foundation surface shall be inspected and approved by the Engineer prior to fill placement. Benching the back cut into competent soil is recommended to improve stability.
- D. Geosynthetic reinforcement shall be installed within the layers of the compacted soil in accordance with the manufacturer's recommendations and as shown on the plans. Geosynthetic reinforcements are to be placed within 3 inches (75 mm) of the design elevations and extend the length as shown on the elevation view unless otherwise directed by the Engineer. Correct orientation of the geosynthetic reinforcement shall be

- verified by the contractor.
- E. Backfill shall be placed, spread, and compacted in such a manner to minimize the development of wrinkles and/or displacement of the geosynthetic reinforcement. Cohesive soils shall be compacted in a maximum loose lift thickness of 8 inches (200 mm) and granular soils in a maximum loose lift thickness of 10 inches (250 mm). Backfill shall be compacted as specified by project specifications or to at least 95 percent of the maximum density determined in accordance with AASHTO T-99, whichever is greater. Backfill shall be graded away from the slope crest and rolled at the end of each work day to prevent ponding of water on surface of the reinforced soil mass. Tracked construction equipment shall not be operated directly upon the geosynthetic reinforcement. A minimum fill thickness of 6 inches (150 mm) is required prior to operation of tracked vehicles over the geosynthetic reinforcement. Turning of tracked vehicles shall be kept to a minimum to prevent tracks from displacing the fill and the geosynthetic reinforcement. If approved by the Engineer and subject to satisfactory performance, rubber-tired equipment may pass over the geosynthetic reinforcement at speeds no greater than 10 mph (16 km/h). Sudden braking and sharp turning shall be avoided.
- F. Erosion Control Material Installation.
1. Delivery, Storage, and Handling. Contractor shall check the erosion control material to ensure that the proper material has been received. During all periods of shipment and storage, the erosion mat shall be protected from temperatures greater than 140 F (60 C), mud, dirt, and debris. Follow manufacturer's recommendations in regards to protection from direct sunlight. At the time of installation, the erosion mat/blanket shall be rejected if it has defects, tears, punctures, flaws, deterioration, or damage incurred during manufacture, transportation, or storage. If approved by the engineer, torn or punctured sections may be removed by cutting a cross section of the mat out. The remaining ends should be overlapped and secured with ground anchors. Any erosion mat/blanket damaged during storage or installation shall be replaced by the contractor at no additional cost to KCMO.
 2. On Site Representative. Erosion control material suppliers shall provide a qualified and experienced representative on site, for a minimum of one day, to assist the contractor and KCMO inspectors at the start of construction. If there is more than one slope on a project then this criteria will apply to construction of the initial slope only. The representative shall also be available on an as needed basis, as requested by the engineer, during construction of the remaining slope(s).
 3. Placement. The erosion control material shall be placed and anchored on a smooth graded, firm surface approved by the engineer. Anchoring terminal ends of the erosion control material shall be accomplished through use of key trenches. The material in the trenches shall be anchored to the soil on maximum 18 inch (450 mm) centers. (Topsoil, if required by construction drawings, placed over final grade prior to installation of the erosion control material shall be limited to a depth not exceeding 3 inches (75 mm)).
 - a. Erosion control material shall be anchored, overlapped, and otherwise constructed to ensure performance until vegetation is well established. Anchors shall be as designated on the construction drawings, with a minimum length of 12 inches (300 mm) recommended, and shall be spaced as designated on the construction drawings, with a maximum spacing of 4 feet (1.2 m) recommended.
 4. Soil Filling. If noted on the construction drawings, the erosion control mat shall be

filled with fine grained topsoil, as recommended by the manufacturer. Soil shall be lightly raked or brushed on/into the mat to fill mat thickness or to a maximum depth of 1 inch (25 mm).

G. Geosynthetic Drainage Composite.

1. Delivery, Storage, and Handling. Contractor shall check the erosion control material to ensure that the proper material has been received. During all periods of shipment and storage, the erosion mat shall be protected from temperatures greater than 140 F (60 C), mud, dirt, and debris. Follow manufacturer's recommendations in regards to protection from direct sunlight. At the time of installation, the erosion mat/blanket shall be rejected if it has defects, tears, punctures, flaws, deterioration, or damage incurred during manufacture, transportation, or storage. If approved by the engineer, torn or punctured sections may be removed by cutting a cross section of the mat out. The remaining ends should be overlapped and secured with ground anchors. Any erosion mat/blanket damaged during storage or installation shall be replaced by the contractor at no additional cost to KCMO.
2. On Site Representative. Geosynthetic drainage composite material suppliers shall provide a qualified and experienced representative on site, for a minimum of one half day, to assist the contractor and KCMO inspectors at the start of construction with directions on the use of drainage composite in conjunction with the geosynthetic reinforced soil system. If there is more than one slope on a project then this criteria will apply to construction of the initial slope only. The representative shall also be available on an as needed basis, as requested by the engineer, during construction of the remaining slope(s).
3. A geotextile flap shall be provided along all drainage core edges. This flap shall be of sufficient width for sealing the geotextile to the adjacent drainage structure edge to prevent soil intrusion into the structure during and after installation. The geotextile shall cover the full length of the core.
4. The geocomposite core shall be furnished with an approved method of constructing and connecting with outlet pipes or weep holes as shown on the plans. Any fittings shall allow entry of water from the core but prevent intrusion of backfill material into the core material.
5. Placement. The soil surface against which the geosynthetic drainage composite is to be placed shall be free of debris and inordinate irregularities that will prevent contact between the soil surface and the drain.
6. Seams. Edge seams shall be formed by utilizing the flap of geotextile extending from the geocomposite's edge and lapping over the top of the fabric of the adjacent course. The fabric flap shall be securely fastened to the adjacent fabric by means of plastic tape or non-water soluble construction adhesive, as recommended by the supplier. Where vertical splices are necessary at the end of a geocomposite roll or panel, an 8 inch (200 mm) wide continuous strip of geotextile may be placed, centering over the seam and continuously fastened on both sides with plastic tape or non-water soluble construction adhesive. As an alternative, rolls of geocomposite drain material may be joined together by turning back the fabric at the roll edges and interlocking the cuspidations approximately 2 inches (50 mm). For overlapping in this manner, the fabric shall be lapped over and tightly taped beyond the seam with tape or adhesive. Interlocking of the core shall always be made with the upstream edge on top in the direction of water flow. To prevent soil intrusion, all exposed edges of the geocomposite drainage core

shall be covered by tucking the fabric flap over and behind the core edge. Alternatively, a 12 inch (300 mm) wide strip of fabric may be utilized in the same manner, fastening it to the exposed fabric 8 inches (200 mm) in from the edge and folding the remaining flap over the core edge.

7. Repairs. Should the fabric be damaged during installation by tearing or puncturing, the damaged section shall be cut out and replaced completely or repaired by placing a piece of fabric that is large enough to cover the damaged area and provide a sufficient overlap on all sides to fasten.
8. Soil Fill Placement. Structural backfill shall be placed immediately over the geocomposite drain. Care shall be taken during the backfill operation not to damage the geotextile surface of the drain. Care shall also be taken to avoid excessive settlement of the backfill material. The geocomposite drain, once installed, shall not be exposed for more than seven days prior to backfilling.

1.7 METHOD OF MEASUREMENT.

- A. Measurement of Geosynthetic Reinforced Soil Slope Systems is on a vertical square foot (meter) basis.
- B. Payment shall cover GRSS design, materials, and installation of geosynthetic reinforcement, backfill, drainage composites, and geosynthetic erosion mat. Excavation of any unsuitable materials and requirement with select fill, as directed by the Engineer shall be paid under a separate pay item.
- C. Quantities of reinforced soil slope system as shown on the plans may be increased or decreased at the direction of the Engineer based on construction procedures and actual site conditions.

1.8 BASIS OF PAYMENT.

The accepted quantities of geosynthetic reinforced soil slope system will be paid for per vertical square foot (meter) of GRSS in place, (Geosynthetic Reinforced Slope System, square feet).

END OF SECTION

SECTION 31 37 00**RIP RAP****PART 1 - GENERAL****1.01 SCOPE OF WORK**

- A. This section governs the performance of all work necessary for construction of slope or bank protection of the type specified in the plans, constructed at locations shown on the plans or as directed by the engineer.

1.02 DESCRIPTION

- A. Rip Rap construction shall consist of furnishing all labor, materials and equipment for the complete installation of rip rap and incidentals in accordance with Contract Drawings and these specifications and as specified in American Public Works Association Standard Specifications and Design Criteria Section 2600 as revised, adopted, and provided by the Director of Kansas City, Missouri Public Works current at the time of bidding and American Public Works Association Standard Specifications.

1.03 REVISIONS OF STANDARDS

- A. In addition to complying with all pertinent codes and regulations, comply with the referenced or applicable portions of the American Public Works Association Standard Specifications and Design Criteria as revised, adopted, and provided by the director of Kansas City, Missouri Public Works current at the time of bidding.
- B. When reference is made to a Standard Specification, i.e., ASTM, ANSI, AWWA, the Specification referred to shall be understood to mean the latest revision of said specifications as amended at the time of the Notice to Bidders, except as noted on the Drawings or in the Specific Project Requirements section of these specifications.

PART 2 - PRODUCTS**2.01 MATERIALS****A. Rip Rap**

1. Rip Rap shall be sound, durable and free from cracks and other structural defects that would cause the revetment to deteriorate. The stone shall not contain any soapstone, shale or other material easily disintegrated. The stone shall be in blocks at least 12 inches thick perpendicular to the slope and shall have approximately rectangular

faces 12 inches wide or more. All stone shall weigh no less than 50 pounds, and at least 60 percent shall weigh no less than 100 pounds.

2. Stone shall consist of quarried rock and be sound, durable, and angular in shape. No more than 10 percent shall have an elongation greater than 3:1, and no stone shall have an elongation greater than 4:1. Material shall be free from cracks, seams, or other defects. Shale and stone with shale seams are not acceptable.
 - a. The minimum unit weight of the stone shall be 165 pounds per cubic foot as computed by multiplying the specific gravity (bulk-saturated-surface-dry basis, AASHTO Test T85) times 62.4 pounds per cubic foot.
 - b. Not more than 10 percent of the stone shall exhibit splitting, crumbling, or spalling when subject to 5 cycles of the sodium sulfate soundness test in accordance with ASTM C 88.
- B. Filter Blanket: Filter blanket shall be installed as shown on the contract drawings.
1. Filter Fabric: Filter fabric shall consist of woven or nonwoven fabric. The synthetic fiber of either the woven or nonwoven fabric shall consist of polypropylene, nylon, or polyester filaments. The percent open area shall be not less than 4 percent nor more than 10 percent. The cloth shall provide an Equivalent Opening Size (EOS) no finer than the U.S. Standard Sieve No. 100. In addition, filter fabric shall meet the following physical requirements:
 - a. Tensile Strength: Minimum grab tensile strength, both warpwise and fillingwise, shall be 200 pounds when tested in accordance with ASTM D 5034, using a 4-inch by 6-inch specimen and a jaw speed of 12 inches per minute.
 - b. Tear Strength: Minimum trapezoid tear strength shall be 100 pounds, both warpwise and fillingwise. Method of test for woven fabrics shall be in accordance with ASTM D 4533.
 - c. Bursting Strength: Minimum bursting strength shall be 400 psi when tested in accordance with ASTM D 3887.
 - d. Seam Strength: Woven fabric shall have a minimum seam-breaking strength of 180 pounds when tested in accordance with ASTM D 1683, using a jaw speed of 12 inches per minute.
 - e. Width: Filter fabric shall be furnished in widths of not less than 6 feet.

PART 3 - EXECUTION**3.01 CONSTRUCTION**

- A. Foundation Preparation: After completion of grading in accordance with Section 31 22 00, the area to receive rip rap shall be trimmed and dressed to conform to the cross sections indicated on the drawings within a tolerance of plus or minus 1 inch from the theoretical slope lines and grades. All deleterious materials shall be removed from the foundation area.
- B. Filter Fabric
1. Place filter fabric with its long dimension horizontal and lay free of tension, stress, folds, wrinkles, or creases.
 - a. Place to provide 18 inches minimum overlap at each joint and anchor to prevent dislocation during construction of overlaying material.
 - b. Fabric shall not be left exposed more than two weeks prior to placement of overlaying material. Tracked or wheeled equipment or vehicles shall not be operated on the fabric.
- C. Riprap Placement: Riprap shall be placed on the prepared foundation in a manner which will provide a reasonably well-graded mass of stone with the minimum practicable percentage of voids.
1. The entire mass of stone shall be placed so as to be in conformance with the lines, grades, and thickness indicated. A filter blanket of filter fabric conforming to Section 2.01 D. entitled "Filter Fabric," shall be constructed under all riprap. Riprap shall be placed to full-course thickness in one operation and in such a manner as to avoid displacing the fabric. The Contractor shall place the riprap in such a way as to not tear, puncture, or shift the fabric. Riprap shall not be dropped more than 3 feet when being placed directly on the fabric. Tears or rips in the fabric shall be repaired with fabric lapped a minimum of 12 inches in all directions.
 - a. Placing: Placing of riprap in layers, or by dumping into chutes, or by similar methods likely to cause segregation will not be permitted.
 - b. Distributing: The larger stones shall be well distributed and the entire mass of stone shall conform to the specified gradation. All materials shall be so placed and distributed that there will be no objectionable accumulations of either the larger or smaller sizes of stone.
 - c. Hand Placing: It is the intent of these specifications to produce a fairly compact riprap protection in which all sizes of material are placed in their proper proportions. Hand placing or rearranging of individual stones by mechanical equipment may be required to the extent necessary to secure the specified results.

2. The slopes shall be compacted to a uniform density as required for adjacent material. The revetment shall be started in a trench below the toe of the slope or at the back face of wall and shall progress upward. Each stone shall be laid perpendicular to the slope, shall be firmly bedded against the slope and against adjoining stones, and shall be laid with well-broken joints. Only one layer of stone perpendicular to the slope will be permitted. After revetment has been placed, the voids shall be filled with spalls or small stones in such a manner that all revetment stones are tightly wedged. The finished surface shall present a uniform appearance true to line, grade and section.

END OF SECTION 31 37 00

SECTION 31 41 00**SHORING****PART I - GENERAL****1.1 SUMMARY**

- A. Description: This Section specifies requirements and performance procedures for the design, furnishing, installing, and maintaining temporary sheeting, shoring, bracing, or other excavation supports required for excavation below the existing grade and the protection of existing structures, pavements, and railroad tracks adjacent to the Work, and their removal during and after construction of the Work.

1.2 REFERENCED STANDARDS AND DOCUMENTS

<u>Sponsor</u>	<u>Number</u>	<u>Subject</u>
ASTM	A 36	Standard Specification of Carbon Structural Steel
ASTM	A 328	Standard Specification for Steel Sheet Piling
ASTM	A 572	Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel
AWPA	T 1	Processing and Treatment Standard
AREMA		Manual of Railway Engineering
OSHA	Title 29	Safety and Health Regulations for Construction, Part 1926

1.3 REGULATORY REQUIREMENTS

- A. Protection and safety: Pursuant to the requirements of the United States Department of Labor Occupational Safety and Health Administration (OSHA), and the Missouri Labor and Industrial Relations Commission, all open excavations greater than 5 feet in depth shall be constructed with bracing, sheeting, shoring or other equivalent method designed for the protection of life and limb. The trench excavation and support system shall comply in all respects with the requirements of OSHA and the Missouri Labor and Industrial Relations Commission Regulations.
- B. Certification: The minimum required protection shall be that described in the Construction Standards of the Missouri Labor and Industrial Relations Commission. If the Contractor uses excavation plans that vary from the shoring system standards established by the Construction Standards, the plans shall be prepared and signed by a licensed civil engineer registered in the State of Missouri.

1.4 SUBMITTALS

- A. Submittals shall be made in accordance with the requirements of the Project Quality Plan, except as modified herein:
- B. Detailed shop drawings, design calculations and installation procedures of an excavation

support system meeting the requirements of all applicable standards and regulations of local, state, and federal agencies having jurisdiction.

1. No plan shall allow the use of shoring, sloping or a protective system less effective than that required by the Construction Safety Orders of the Division of Occupational Safety and Health. If the plan complies with the shoring system standards established by the Construction Safety Orders, the plan shall be submitted at least 5 days before the Contractor intends to begin excavation for the trench. If the plan varies from shoring system standards established by the Construction Safety Orders, the plan shall be prepared and signed by an engineer who is registered as a Civil Engineer in the State of Missouri and the plan and design calculations shall be submitted at least 3 weeks before the Contractor intends to begin excavation for the trench.
 2. Plans of the shoring details for excavations on or affecting railroad property will be reviewed for adequacy of protection provided for railroad facilities, property and traffic. Those plans shall be submitted at least 12 weeks before the Contractor intends to begin excavation requiring the shoring. Approval by the Engineer of the plans for the shoring details will be contingent upon the plans being satisfactory to the railroad company involved.
- C. Dewatering system in conformance with the requirements stipulated in Section 31 23 19 Construction Dewatering.
- D. Instrumentation program to monitor the excavation support system and adjacent structures for movement, stability, effectiveness, and settlement. List the type, brand, quantity, and model number of the instrument to be deployed, proposed locations, and manner of installation. Include record forms and record frequency and remedial measures in case of emergency in the program. The recorded data shall be transmitted to the Engineer within 7 calendar days of the recorded activities.
- E. As part of the design, the Contractor shall prepare an action plan for each measured parameter indicating what is considered to be "normal" behavior so abnormalities may be recognized. The action plan shall indicate the limiting magnitudes and modes of acceptable ground behavior, or hazard warning level, that will require remedial action if these limits are exceeded. The action plan shall include appropriate remedial or contingency activities required when the hazard warning level for any measurement is exceeded.
- F. When the construction sequence of structures requires the transfer of bracing to the completed portions of any structure, the Contractor shall submit request to secure written acceptance from the Engineer prior to the installation of such bracing.
- G. Submittals shall be signed by a professional civil engineer currently licensed and registered in the State of Missouri.

1.5 QUALITY CONTROL

- A. Quality control shall be made in accordance with the General Provisions, except as modified herein.
- B. Protect all utilities, structures and facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by excavation and backfill operations.
- C. Excavation support systems shall be designed for surcharge loads from construction

equipment, excavation spoil, storage, tracks, structures and appropriate seismic loads. The excavation supports shall provide adequate protection against lateral movement or settlement of the existing structures, above and below grade, and tracks adjacent to the Work.

- D. Qualifications:
1. The Contractor shall have a minimum of 3 years proven experience in providing the types of excavation support system proposed for the project.
 2. The design engineer shall have a minimum of 3 years proven experience in the design of the type of excavation support system proposed for the project in similar magnitude and soil conditions.
- E. The Contractor shall be solely responsible for any and all liabilities that may arise from his failure to provide adequate excavation supports as necessary to support the excavation under any or all of the conditions of loading that may exist or arise during the construction.

1.6 SUBSURFACE CONDITIONS

- A. The reports on the soil and subsurface conditions are available for examination in the Engineer's office. Soil conditions between borings and soundings may vary in an irregular manner. The Engineer assumes no responsibility for any such variations that may exist, nor for any deductions or conclusions the Contractor may make from information made available by the Engineer.
- B. The Contractor shall be responsible for performing any additional investigations, testing, or analyses required for the design of the excavation support system.

1.7 SITE CONDITIONS

- A. The Contractor's design engineer shall visit the site to evaluate existing conditions, including access, nature and extent of existing improvements, and other factors that may affect the work under this section.

PART II - PRODUCTS

2.1 SHORING SYSTEMS

- A. General: any proven systems of internal shoring or bracing that are compatible with site conditions.
- B. Materials: Materials for excavation support systems shall be new, or in good condition as determined by the Contractor's design engineer.
- C. In areas where groundwater table is at least 2 ft below the excavation bottom, timber lagging with rail piles may be used, while in areas with higher groundwater table, a watertight support system should be selected.

2.2 MATERIALS

- A. Steel H Piles: ASTM A36.
- B. Timber Lagging: Treated Douglas Fir (1250 psi) conforming to AWPA T1.

- C. Steel Sheet Piling: ASTM A328 or ASTM A572, Grade 50.

2.3 INSPECTIONS

- A. The Engineer may perform periodic inspections of the excavation support system, but such inspections shall in no way relieve the Contractor of responsibility under the terms of the Contract.
- B. The Contractor's design engineer shall perform inspections of the installation and operation of the excavation support system to assure that site conditions are consistent with those assumed in the design and that the system is functioning accordingly.

PART III - EXECUTION

3.1 CONTRACTOR'S RESPONSIBILITY

- A. Assess the extent and nature of excavation support required in the Work. There may be situations where shoring components may have to be left in place after the construction.
- B. Perform site reconnaissance survey and collect available record drawings of existing structures, rail tracks, and utilities for conditions and limitations which may influence the Work required by this Section.

3.2 SHEETING, SHORING AND BRACING

- A. Excavations shall be properly and adequately shored or braced to provide safe and acceptable working conditions, protect existing and new structures, protect existing roads and tracks, and maintain existing slopes and fills. The temporary sheeting, shoring, or bracing shall not place any stress on portions of the completed work until the construction thereof has proceeded far enough to provide adequate strength.
- B. Where required for safety and governing laws, or as directed by the Engineer, temporary sheeting shall be left in place. In such instances, remove original braces and re-brace sheeting against structure as approved by the Engineer. Sheeting shall be cut off a minimum of 2 feet below existing grade unless otherwise directed by the Engineer.
 - C. Where Contractor elects to slope sides of excavations, backfill of over-excavated areas shall be made in same manner specified for adjacent excavated area. All additional backfills shall be at Contractor's own expense.

3.3 COFFERDAMS

- A. Cofferdams for foundation construction shall be carried well below the bottom of the footings and shall be well braced and as watertight as practical. The interior dimensions of cofferdams shall provide sufficient clearance inside the wales for constructing forms and driving piles and to permit pumping outside the forms.
- B. If in the judgment of the Contractor, the clearance provided on the plans between the outside line of the footing and any pile or interior wall or surface is not sufficient to permit the driving of piles or building of forms, the Contractor may provide the necessary clearance by constructing the cofferdam sufficiently large to provide such clearance as the Contractor may deem necessary. Any enlargement in excess of 2 foot outside the dimensions of the footing as shown on the plans shall be considered as being for the sole purpose of expediting the work of the Contractor, and the quantities of any additional

excavation and backfill will not be included in the quantities to be paid for.

- C. Cofferdams which are tilted or moved out of position by any cause during the process of sinking shall be righted or enlarged so as to provide the necessary clearance and proper pier location, and that work shall be done by the Contractor at the Contractor's expense.
- D. No shoring will be permitted in cofferdams which will induce stress, shock or vibration in the permanent structure.
- E. When permitted by the Engineer, cross struts or bracing may extend through foundation concrete. Struts or bracing below low water will be permitted to remain in place, except in navigable streams or when shown on the plans, to be removed. Struts or bracing above low water shall be removed and the resulting space filled with concrete of the same mix as that specified for the surrounding concrete.

3.4 STABILITY OF EXCAVATIONS

- A. Provide safe and stable excavations for protection of workers and for protection of structures in the vicinity of excavations from any damage due to movement and settlement of soils and alterations in the ground water level.

The above provision is to complement, and not to substitute or diminish, the obligations of the Contractor for the furnishing of a safe place of work pursuant to the current provisions of Missouri/OSHA specified herein.

- B. Shoring shall be provided at all locations as defined below:
 - 1. Excavation is 5 ft or deeper.
 - 2. Excavated face or surrounding soil mass may be subject to slides, caving, flow or boiling.
 - 3. Stability or integrity of new and existing structures and other improvements may be compromised by ground settlement or movement.
 - 4. In areas shoring methods are not deployable, use alternative soil stabilization measures subject to Engineer's review and approval.
- C. Design Calculations:
 - 1. Design calculations shall describe clearly the assumptions made, the criteria followed, and the stress values used for the various materials and methods.
 - 2. Design calculations shall include acceptable references substantiating the appropriateness of the design assumptions, criteria, and stress values.
- D. Design Criteria:
 - 1. Excavation supports shall be designed in accordance with accepted engineering design practice. Design shoring of excavations for Cooper E80 live load surcharge, in areas as applicable.
 - 2. Construction equipment load and storage load shall be considered as appropriate.
 - 3. Design involving materials other than steel shall be in accordance with the IBC

- (International Building Code) and other referenced standards. The most restrictive standards shall apply.
4. Design shall be made in accordance with soil characteristics and engineering parameters derived from Contractor's own geotechnical exploration with referenced information contained in other soil reports prepared for the project.
 5. Limit movement at and behind the shoring to less than 2-inch vertically and horizontally.
 6. Limit vertical settlement and horizontal movement of existing structures, buildings, and utilities to less than 1-inch.
 7. Limit vertical settlement and horizontal movement of tracks in the vicinity of excavation to one inch or a level acceptable to the rail operation company. Coordinate with the operation company to establish the acceptable criteria prior to commencement of any excavation work.
 8. Design shall take into account dewatering activities inside and outside of the excavations.
- E. Strictly follow shoring installation sequence stipulated in the approved shop drawings and design calculations. Alteration to the sequence is permitted only with written consent from the Engineer.
1. Preventing soil loss through or under the shoring. The shoring shall be tight enough to prevent loss of soil and shall be extended deep enough to prevent heave or flow of soil from the supported soil mass into the excavation.
 2. Providing surface runoff path and discharge away from the excavations.
 3. Stabilizing the groundwater level as necessary. Performing dewatering, when necessary, in such a manner as to prevent settlement in the excavation and in the surrounding area in compliance with the requirements specified in Section 31 23 19 Dewatering, and as specified herein.
 4. Prior to shoring installation, establishing control points in accordance with accepted submittal, and monitoring the shoring systems thru installation and entire construction, until their removal.
 5. Not applying shoring loads to structures and other improvements.
 6. Not changing existing soil loading on structures and other improvements without the prior approval of the Engineer.
- F. Maintenance:
1. Where loss of soil occurs, the Contractor shall plug the gap in the shoring and shall replace the lost soil with suitable fill material.
 2. Where measurements and observations indicate the possibility of failure of the excavation, Contractor shall take appropriate action immediately, and shall report to the Engineer in writing.

3.5 TESTS AND INSPECTIONS

- A. Record and evaluate the observation data, both horizontal and vertical movements of shoring control points. Monitoring the shoring systems in accordance with the accepted submittals. Provide round-the-clock monitoring of shoring systems if severe weather conditions so require.
- B. Submit to the Engineer weekly reports on accepted forms, plus a final report on the status of the complete shoring system.

3.6 REMOVAL

- A. Maintain the shoring and dewatering systems until they are no longer needed. Obtain Engineer's concurrence first.
- B. Upon removal of the support systems, backfill per Section 31 22 00, patch any gaps in permanent structures where shoring members were located, and fill holes left by geotechnical exploration and instrumentations. Dispose rubbish materials off the site.
- C. Sheet piling and timbers, if used in the excavation supports, shall be withdrawn in a manner so as to prevent subsequent settlement of the ground. Sheeting left in place shall be at least 2 ft below the ground.

PART 4 - MEASUREMENT

- 4.1 Measurement** – No Separate measurement will be made for Work described in this Section.

PART 5 - PAYMENT

- 5.1 Payment** – No separate payment will be made for shoring. All costs pertaining thereto shall be included in the Contract Unit Prices for other items as listed in the Bid Form-Unit Prices.

END OF SECTION

SECTION 31 63 29
DRILLED PIERS**PART 1 - GENERAL****1.1 SUMMARY**

- A. Furnish all labor, materials, tools, equipment, and services for Drilled Piers, as indicated, in accordance with provisions of Contract Documents.
- B. Definitions:
 - 1. Geotech: Representative of soils and foundation consultant hired by Owner to inspect pier installation.
 - 2. Obstruction: Unanticipated, unnatural, man made object projecting within pier shaft, greater than 0.03 m³ 1 CU FT in size, which cannot be drilled by use of normal earth drilling techniques and tools; an obstruction does not include cobbles, boulders, bedrock seams or naturally deposited material which may require a rock auger for removal.
 - 3. Rock excavation: Removal of natural material which has a production rate less than 610 mm 2 FT per HR with an earth auger or underreaming tool in good condition using a drill rig with a rated for the geotechnical conditions expected at the site.
 - 4. Caisson: Terms caisson and drilled pier are intended to mean one and the same and may be used interchangeably herein.
 - 5. Bearing strata:
 - a. Bearing layer, material or zone identified in soils report as capable of providing stated bearing capacities.
 - b. Geotech is sole judge as to when bearing strata is reached.
- C. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

- A. Subsurface soils investigations have been made at project site:
 - 1. Soils information was obtained for use in preparing foundation design.
 - 2. Availability of soils information is indicated in specifications.
 - 3. Examine site and soils report and determine character of materials to be encountered.
 - 4. Additional test borings and other exploratory operations may be made, provided such operations are acceptable to Architect.
- B. Installer qualifications: Minimum of 3 years' experience in drilled pier work, including experience with similar work and similar sub-surface conditions.
- C. Layout and measurement of piers, required for work and for specified reports, performed by a licensed surveyor employed by Contractor.
- D. Facilitate inspection by Geotech of pier excavation prior to concrete placement.
- E. Minimum bearing value of material at bottom of piers and bearing stratum as defined on the drawings.
- F. Testing:
 - 1. Routine testing of concrete for compliance with Contract Documents will be paid for by the Contractor.
 - 2. Pay for testing by independent testing agency necessary to secure initial materials and mix design approval.
 - 3. Provide sufficient notification of concrete placement, access for testing agency, concrete for testing and adequate storage facilities for test cylinders.

4. Pay for additional testing required by Architect in order to evaluate piers failing to meet requirements of Contract Documents.

G. Tolerances:

1. Plumbness: Measured from center of hole: Not more than 1 percent of shaft length, or 12-1/2 percent of shaft diameter, whichever is less.
2. Location of shaft at cut-off elevation: Not more than 50 mm 2 IN.
3. Diameter: Not less than specified.

1.3 SUBMITTALS

A. Shop Drawings:

1. Reinforcing drawings per section 03 20 00 Concrete Reinforcement

B. Product Data:

1. Concrete Mix Designs per section 03 31 00 Concrete Materials and Proportioning
2. Material certificates for permanent casing materials

C. Project Information:

1. Names of three past successful installations under similar conditions.
2. Concrete: Comply with Section 03 31 00.
3. Report for each pier:
 - a. Pier location by column grid lines.
 - b. Date and time of starting and completing excavation noting periods of delay for obstructions.
 - c. Bottom elevation of pier.
 - d. Cut-off elevation of pier.
 - e. Total length of pier from bottom to cut-off elevation.
 - f. Depth drilled into bearing stratum.
 - g. Diameter of pier shaft including variations from design.
 - h. Pier location at top and bottom of shaft, and verification of plumbness and location tolerances.
 - i. Description of soil materials and bearing capacity
 - j. Signature of Geotech that excavation was inspected and approved for concrete placement.
 - k. Corresponding concrete test cylinder numbers (obtain from testing agency).
 - l. Unusual conditions encountered including but not limited to;
 - 1) Groundwater conditions and infiltration rate depth and pumping.
 - 2) Descriptions, locations and dimensions of obstructions and removal thereof.
 - 3) Properties of slurry and slurry tests at time of slurry placement per ACI 336.1 should slurry be required.

1.4 BASE BID PRICE ADJUSTMENT

- A. Base bid shall be for lengths, size and volume derived from the structural drawings.
- B. Adjustment of contract price will be made on basis of unit prices included on proposal form times variation between total accumulated installed length and base bid length of piers as scheduled for each diameter and material.
- C. No adjustments will be made for variation in lengths of individual piers.
- D. Base bid shall anticipate and include drilling required above top of caisson elevation.
- E. No adjustment of contract price will be made for variations in type or length of material encountered above top of caisson.
- F. No adjustment of contract price will be made for frequency of auger and bit changes required for changes in material.
- G. Measurement of length:

1. Measure lengths between bottom and top of caisson as detailed and defined on plans.
2. Measure length of rock drilling and earth drilling as identified herein and established by Engineer in field.
3. Do not include volume resulting from over drilling.
4. Do not include rejected piers.
5. Include obstructed piers and replacement piers for obstructed piers.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Concrete:
 1. Conform to Section 03 31 00.
 2. Do not use concrete which has had water added more than one hour before placement.
- B. Reinforcing steel:
 1. Conform to Section 03 20 00.
 2. Dimensions as indicated.
- C. Concrete admixtures: As permitted in Section 03 31 00.
- D. Casings (when required):
 1. Steel cylinders.
 2. Wall thickness as required for loads.
 3. Weld sections together, watertight.
 4. Loose section for cleaning and inspection of pier bottom.
 5. Extend to bottom of straight pier or to top of bell, unless otherwise approved.

PART 3 - EXECUTION

3.1 LAYOUT

- A. Locate piers as indicated.

3.2 INSTALLATION

- A. Perform both excavation and concrete placement for a pier on same day.
- B. Perform work with Hughes LDH or equivalent heavy duty pier drilling rig, maintained in satisfactory working condition, operated by competent and experienced person.
 1. Provide qualified, experienced, and direct supervision in field for pier drilling, and concrete filling of piers.
 2. Use loose safety casing whenever man is in hole.
 3. Provide other required safety procedures.
- C. Provide piers with straight shaft with or without belled bottoms as indicated.
 1. Size and cut to accurate dimensions according to sizes and elevations indicated.
 2. Hand clean bell or shaft to satisfaction of soils consultant.
 3. Cover excavation between operations.
 4. Remove foreign and loose material from approved excavation.
- D. Install a 50 mm 2 IN diameter pneumatically drilled probe hole for inspection of rock continuity in each caisson after potential bearing strata is reached.
- E. Depth of probe hole smaller than 1.5 times caisson diameter or 3050 mm 10 FT.
- F. Approximate pier bottom elevations may be indicated as a guide for Contractor.

- G. Actual depth of pier determined at time of drilling by Geotech.
- H. Report underground obstructions to Geotech.
 - 1. When directed by Geotech, remove obstruction as extra work.
 - 2. Fill shaft with concrete when Geotech determines obstruction cannot be removed.
 - 3. Provide replacement pier or piers as directed by Geotech.
- I. At no additional cost, case pier shafts as necessary, to prevent caving and to shut off flow of ground water.
- J. Belling in a dry shaft below casing.
- K. Maintain excavations in essentially dry condition, using pumps where necessary.
- L. Have pier inspected by Geotech prior to placing concrete.
- M. Provide safety casing for cleaning and inspection.

3.3 REINFORCEMENT

- A. Place steel reinforcing cage in pier hole after inspection and approval of excavation and subgrade.
- B. Adequately support reinforcement to assure concentric alignment and adequate concrete cover over reinforcing.
- C. Place dowels and/or anchor bolts extending from top of pier prior to final concrete placement.

3.4 CONCRETE PLACEMENT

- A. After approval and placement of reinforcing steel, place concrete as soon as possible.
- B. Place in manner to preclude segregation, infiltration of water, or other occurrence which would tend to decrease strength of concrete or supporting capacity of finished pier.
- C. Place concrete in such a manner so as to limit free fall to 1220 mm 4 FT, unless it can be satisfactorily demonstrated that concrete may free fall without segregation and/or striking sides of excavation or reinforcing.
 - 1. If excavation contains more than 150 mm 6 IN of water, use tremie method to place concrete.
 - 2. Use tremie between 205 and 305 mm 8 and 12 IN diameter.
 - 3. Provide positive control to insure that bottom of tremie pipe is at all times at or below concrete surface.

3.5 WITHDRAWAL OF CASING

- A. When pulling casing, maintain level of concrete above bottom of casing greater or equal to level of ground water.
 - 1. Keep bottom of liner at least 3050 mm 10 FT below top of concrete.
 - 2. Prevent insitu materials from falling into and mixing with concrete.
- B. Pull casing in short slow vertical lifts (essentially continuous), maintaining plumb, and sufficient head of concrete.
- C. Allow continuous observation of interior level of concrete.
- D. If reinforcing is not required, vibrate only top 4570 mm 15 FT of concrete.
- E. If reinforcing steel is used, vibrate full height of reinforcing or 4570 mm 15 FT, whichever is greater.

3.6 REJECTED PIERS

- A. Replace rejected piers.

- B. Piers may be rejected for following reasons:
 - 1. Concrete not reaching minimum 28 day design strength.
 - 2. Piers out of horizontal and vertical alignment, in excess of tolerances indicated.
 - 3. Piers of improper size and depth.
 - 4. Installation not complying with specifications.
- C. Pay for additional engineering work required for redesign due to rejected piers.

END OF SECTION

SECTION 31 66 13.15**RAMMED PIER GROUND IMPROVEMENT****PART 1 - GENERAL****1.1 SUMMARY**

- A. Rammed pier ground improvement is required below retaining walls for this project to improve bearing capacity and reduce settlement. Work under this section shall consist of designing, furnishing and installing rammed pier ground improvement for the structures indicated and as specified herein. The rammed piers shall be high modulus columns of compacted aggregate for support of foundation loads.
- B. Related Work Specified Elsewhere
 - 1. Site Preparation and Earthwork: SECTION 31 22 00

1.2 WORK INCLUDED

- A. Provide all equipment, material, labor, and supervision to design and install rammed piers.
- B. The rammed pier design and installation shall adhere to all methods and standards described in this Specification.
- C. Layout of rammed piers, spoil removal, dewatering, footing excavations, subgrade preparation following rammed pier installation, and all other associated work is included.

1.3 QUALIFICATIONS

- A. Contractor shall have a minimum of 5 years of experience with the installation of rammed pier systems and shall have completed at least 10 projects of a similar scope and nature.
- B. At the time of bid, submit a qualification statement demonstrating the required experience.

1.4 REFERENCES

- A. Modulus Testing
 - 1. ASTM D 1143 – Standard Test Method for Deep Foundations Under Static Axial Compressive Load
 - 2. ASTM D 1194 – Standard Test Method for Bearing Capacity of Soil for Static Load and Spread Footings
- B. Materials
 - 1. ASTM D 1241 – Standard Specification for Materials for Soil-Aggregate Subbase, Base, and Surface Courses
 - 2. ASTM D 422 – Standard Test Method for Particle-Size Analysis of Soils

1.5 SUBMITTALS AND CONSTRUCTION RECORDS

- A. Building Code Acceptance – Contractor shall demonstrate that their proposed rammed pier system has been evaluated by the International Code Council (formerly ICBO).
- B. Modulus Test Reports – Perform a minimum of one (1) modulus test on a non-production rammed pier element and additionally as required by Contractor to verify the design assumptions. Contractor shall furnish Engineer a description of the installation equipment, installation records, complete test data, analysis of the test data and verification of the design parameter values based on the modulus test results. The report shall be prepared under direction of a Registered Professional Engineer in the State of Missouri. Report shall be submitted to Owner within 2 days of test completion and a minimum of 3 days prior to start of production work.
- C. Daily Rammed Pier Progress Reports – Furnish daily a complete and accurate record of rammed pier installation to Owner. The record shall indicate the pier location, length, volume of aggregate used, number of lifts, densification forces during installation, and final elevations or depths of the base and top of piers. The record shall also indicate the type and size of the installation equipment used, and the type of aggregate used. Immediately report any unusual conditions encountered during installation to Owner.
- D. Design Submittal - Contractor shall submit detailed design calculations, construction drawings, and shop drawings, (the Design Submittal), for review by Owner and Engineer at least 3 week(s) prior to the beginning of construction. A detailed explanation of the design parameters and calculations that demonstrate that the required allowable bearing capacity and settlement tolerances are met for settlement calculations shall be included in the Design Submittal . Provide a detailed installation sequence, procedure and proposed schedule. Additionally, the quality control test program for rammed pier system, meeting these design requirements, shall be submitted. All calculations and drawings shall be prepared and sealed by a Professional Engineer, licensed in the State of Missouri.

1.6 RAMMED PIER DESIGN

- A. The design of the rammed pier system shall be based on the service load bearing pressure and the allowable total and differential settlement criteria indicated.
- B. The rammed pier system shall be designed in accordance with generally-accepted engineering practice.
- C. The design life of the structure shall be 50 years.
- D. The rammed pier system shall be designed to preclude plastic bulging deformations at the top of pier at the design stress and to preclude significant tip stresses as determined from the shape of the telltale test curve from telltales installed in modulus test piers.
- E. The rammed pier elements shall be designed using a rammed pier stiffness modulus to be verified by the results of the modulus test described in PART 3 of these specifications.

PART 2 - PRODUCTS

2.1 AGGREGATE

- A. Aggregate for pier construction shall demonstrate suitable performance during modulus testing. Aggregate shall consist of Type 1, Gradation B in accordance with ASTM D-1241 and ASTM D-422, or No. 57 stone.

- B. Aggregate used for piers constructed below the water table shall be Type 1 Gradation B, except that particles passing the No. 40 sieve shall be eliminated. Alternatively, No. 57 stone may be used.
- C. Potable water or other suitable source may be used to increase aggregate moisture content where required.

PART 3 – EXECUTION

3.1 SITE PREPARATION AND PROTECTION

- A. Locate and protect underground and aboveground utilities and other structures from damage during installation of the rammed piers.
- B. Site grades for rammed pier installation shall be within one foot of the top of footing elevation or finished grade elevation to minimize rammed pier installation depths.
- C. Establish and maintain a working surface to provide wet weather protection of the subgrade and to provide access for efficient operation of the rammed pier installation.
- D. Prior to, during and following rammed pier installation, provide positive drainage to protect the site from wet weather and surface ponding of water.
- E. Spoil removal from the rammed pier work area shall be performed in a timely manner to prevent interruption of rammed pier installation. Stockpile spoil materials on site at a location designated by Owner.

3.2 INSTALLATION PROCEDURES

- A. The installation method used for rammed pier construction shall be that used in the construction of the successful modulus test.
- B. The location of rammed pier-supported foundations for this project, including layout of individual rammed pier elements, shall be marked in the field using survey stakes or similar means. Rammed piers shall be installed to within 6 inches of required locations.
- C. Rammed piers shall be installed to an undisturbed, competent, and native soil layer or bedrock.
- D. Rammed piers shall be pre-augered using mechanical drilling or excavation equipment.
- E. If cave-ins occur during excavation such that the sidewalls of the hole are deemed to be unstable, temporary steel casing shall be used to stabilize the cavity.
- F. Aggregate shall be placed in the augered cavity in loose lift thicknesses as determined by Contractor, but in no case greater than 24 inches in thickness.
- G. Should cave-ins occur on top of a lift of aggregate such that the volume of the caved soil is greater than 10 percent of the volume of the aggregate in the lift, then the aggregate shall be considered contaminated and shall be removed and replaced with uncontaminated aggregate.
- H. Special high-energy impact densification apparatus shall be employed to densify the rammed pier elements during installation. The apparatus shall apply direct downward impact energy to each lift of aggregate.

- I. A minimum tamper energy level of 250,000 foot-pounds of force per minute shall be applied by the energy source.
- J. Downward pressure shall be applied to the tamper shaft during tamping.
- K. Each lift of aggregate shall be tamped for a minimum of 15 seconds.
- L. Excavations for Obstructions
 - 1. Should any obstruction be encountered during rammed pier installation, promptly remove such obstruction and continue with installation of the pier, or the pier shall be abandoned and relocated as directed. Obstructions include, but are not limited to, boulders, timbers, concrete, bricks, utility lines, etc., which shall prevent placing the piers to the required depth, or shall cause the pier to drift from the required location.
 - 2. Dense natural rock or weathered rock layers shall not be deemed obstructions, and piers shall be terminated on such materials.
- M. Contractor shall provide a full-time Quality Control technician on-site during the installation process

3.3 REJECTED RAMMED PIERS

- A. Rammed pier elements installed beyond the maximum allowable tolerances or otherwise not in accordance with this specification shall be abandoned and replaced with new piers. All material and labor required to replace rejected piers shall be provided at no additional cost to the Owner, unless the cause of rejection is due to an obstruction.

3.4 RAMMED PIER MODULUS TEST

- A. A minimum of one (1) Modulus Test shall be completed at a mutually agreed upon location. If additional tests are needed to verify the design, submit proposed locations for those additional tests. Test procedures shall utilize appropriate portions of ASTM D 1143 and ASTM D 1194. Rammed piers shall be tested to 150 percent of the maximum design stress as shown in the rammed pier design submittal. The rammed piers for modulus tests shall be of the type and installed in a manner specified herein. Contractor shall notify the Owner of the date of testing at least 1 week before testing is to occur.
- B. A telltale shall be installed at the bottom of the test pier so that bottom-of-pier deflections may be determined. Acceptable performance is indicated when the bottom of the pier deflection is no more than 30% of the top of pier deflection at the design stress level.
- C. ASTM D-1143 general test procedures shall be used as a guide to establishing load increments, load increment duration, and load decrements. As a minimum, the following loading increments, decrements and duration shall be used.

<u>Increment</u>	<u>Approximate Load (percent design)</u>	<u>Minimum Duration (min)</u>	<u>Maximum Duration (min)</u>
Seat	5	0	N/A
1	15	15	60
2	30	15	60
3	45	15	60
4	60	15	60
5	75	15	60
6	90	15	60
7	105	15	60
8	120	15	60
9	135	15	60
10	150	60	120
11	112.5	5	N/A
12	75	5	N/A
13	37.5	5	N/A
14	0	5	N/A

- D. With the exception of the load increment representing approximately 150% of the design maximum top of rammed pier stress, all load increments shall be held for a minimum of 15 minutes. Loads shall be maintained until the rate of deflection reduces to 0.01 inch per hour or for a maximum of 1 hour, whichever is occurs first.
- E. The load increment that represents approximately 150% of the design maximum stress on the rammed pier shall be held for a minimum of 60 minutes. Loads are then maintained until the rate of deflection reduces to 0.01 inch per hour or for a maximum of 2 hours, whichever occurs first.
- F. A seating load equal to 5 percent of the total load shall be applied to the loaded steel plate prior to application of load increments and prior to measurement of deflections to compensate for surficial disturbance.
- G. Contractor shall monitor the modulus test pier installation and testing and shall provide and install for testing all dial indicators and other measuring devices required.

3.5 BOTTOM STABILIZATION TESTING (BSTs) / CROWD STABILIZATION TESTING (CSTs)

- A. Bottom stabilization testing (BSTs) or Crowd stabilization testing (CSTs) shall be performed by the Quality Control Technician during the installation of the modulus test pier. The tests are performed by applying downward vertical energy to the tamper, mandrel or probe following lift construction and monitoring the amount of additional deflection from the applied energy. Additional testing as required by the Rammed Pier Designer (typically 10% of the production rammed piers) shall be performed on selected production rammed pier elements to compare results with the modulus test pier.

3.6 QUALITY CONTROL MONITORING

- A. Contractor shall have a full-time, on-site Quality Control Technician to verify and report all installation procedures to verify that the production practices meet the design assumptions and are similar to those used during installation of the modulus test elements.

- B. Contractor shall immediately report any unusual conditions encountered during installation to the Owner. The quality control procedures shall include the preparation of Rammed Pier Progress Reports completed during each day of installation containing the following information:
1. Structure and rammed pier location/number.
 2. Pre-auger diameter and soil conditions encountered during drilling.
 3. Type of aggregate used.
 4. Rammed pier length.
 5. Planned and actual rammed pier elevations at the top and bottom of the rammed pier.
 6. Average lift thickness of each rammed pier.
 7. Tamping time for each lift.
 8. Volume of aggregate used in each rammed pier.
 9. Documentation of any unusual conditions encountered.
 10. Type and size of densification equipment used including densification forces during installation.
- C. Perform Dynamic Cone Penetration testing to evaluate the footing bottom condition, as required.

3.7 OWNER'S INDEPENDENT TESTING AGENCY (OWNER'S QUALITY ASSURANCE)

- A. Owner may acquire an Independent Testing Agency (Quality Assurance) as required.
- B. Contractor shall cooperate with Owner's Quality Assurance Personnel.

3.8 EXCAVATIONS

- A. Coordinate all excavations made subsequent to rammed pier installations so that excavations do not encroach on the piers as shown in the rammed pier construction drawings. Protection of completed rammed piers is the responsibility of the Contractor. In the event that excavations are required in close proximity to the installed rammed piers, Contractor shall contact the Rammed Pier Designer immediately to develop construction solutions to minimize impacts on the installed rammed pier elements.

3.9 FOOTING BOTTOMS

- A. Foundation excavations to expose the tops of rammed piers shall be made in a workman-like manner, and piers shall be protected until concrete placement, with procedures and equipment best suited to:
1. Avoid exposure to water,
 2. Prevent softening of the matrix soil between and around the rammed piers before pouring structural concrete, and

3. Achieve direct and firm contact between the dense, undisturbed rammed piers and the concrete footing.
- B. All excavations for footing bottoms supported by rammed pier foundations shall be prepared in the following manner:
1. Limit over-excavation below the bottom of the footing to 3-inches (including disturbance from the teeth of the excavation equipment).
 2. Compaction of surface soil and top of rammed piers shall be prepared using a motorized impact compactor ("Wacker Packer," "Jumping Jack," or similar). Sled-type tamping devices shall only be used in granular soils and when approved by the designer. Loose or soft surficial soil over the entire footing bottom shall be recompacted or removed. The surface of the rammed pier shall be recompacted prior to completing footing bottom preparation.
 3. Place footing concrete immediately after footing excavation is made and approved by Owner, preferably the same day as the excavation. Footing concrete must be placed on the same day if the footing is bearing on moisture-sensitive soils as determined by Owner. If same day placement of footing concrete is not possible, open excavations shall be protected from surface water accumulation. A lean concrete mud-mat may be used to accomplish this.
- C. The following criteria shall apply, and a written inspection report shall be furnished to Owner to confirm:
1. That water has not been allowed to pond in the footing excavation at any time.
 2. That all rammed piers designed for each footing have been exposed in the footing excavation.
 3. That immediately before footing construction, the tops of rammed piers exposed in each footing excavation have been inspected and recompacted as necessary with mechanical compaction equipment.
 4. That no excavations have been made after installation of rammed pier elements within the excavation limits described in the rammed pier construction drawings, without the written approval of the Rammed Pier Designer.

3.10 MEASUREMENT AND PAYMENT

- A. Measurement
1. Measurement of the rammed piers is on a lump sum basis.
- B. Payment
1. Payment shall cover design, mobilization, supply of materials, site preparation, installation of rammed pier foundation system, layout, modulus testing, quality control, and all related activities associated with the work.

END OF SECTION

SECTION 32 01 16.71**COLD MILLING ASPHALT PAVING****PART I - GENERAL****1.1 SUMMARY**

- A. Description
 - 1. This Section covers the rotomilling of existing asphalt pavement surfaces as shown on the Contract Drawings, and as specified herein.

1.2 SUBMITTALS

- A. Submittals shall be made in accordance with the requirements of the Project Quality Plan, except as modified herein.
- B. Prior to start of work submit:
 - 1. Details of protection to existing covers frames and monuments.
 - 2. List of equipment to be used for operation.
 - 3. Work plan which shall include dates and times of operation; traffic control measures, before, during, and after rotomilling operation; anticipated dates of overlay placement.

1.3 QUALITY ASSURANCE/QUALITY CONTROL

- A. Quality assurance/quality control shall be made in accordance with the requirements of the Project Quality Plan.

PART II - PRODUCTS - NOT USED**PART III - EXECUTION****3.1 EQUIPMENT**

- A. Power-operated track propelled planning machine or grinder shall be used which is:
 - 1. Capable of milling to plan cross slope.
 - 2. Self-propelled with sufficient power, traction, and stability to maintain accurate depth of cut.
 - 3. Maximum of 5/8-inch between the cutting teeth on the mandrel.
- B. Appropriate cleaning equipment capable of sweeping and picking up millings to clean up after milling operation shall be used.

3.2 PROCEDURE

- A. Existing bituminous pavement surface shall be rotomilled to the width and depth shown on the plans to an accuracy of $\pm 3/8$ -inch of plan depth, measured from original surface to the top of the ridge.
 - 1. Depth tolerance shall be maintained. Skis or other profile grade control devices shall not be used if the specified depth tolerance cannot be met with their use.
- B. The area directly surrounding manholes, catch basins, water meters, water valves or any other permanent fixtures shall be rotomilled to the specified depth.
- C. The Engineer:
 - 1. Will measure and record rotomilling depths, taking two random measurements every 1,000 ft of each pass of the milling machine.
 - 2. May adjust the depth of the milling operation, within tolerances, to remove unacceptable material or to improve ride.
- D. The reclaimed material from milling operation shall be loaded into a truck in one operation. Milled material is the property of the Contractor, unless specified otherwise.

3.2 CLEANING AND REPAIR

- A. All millings shall be removed and cleaned from the surface daily. Dust created by the cutting action shall be controlled. Rotomilled surface shall be cleaned after milling operation and prior to opening to traffic, meeting environmental regulations for cleaning process.
- B. Contractor shall remove and replace, or repair damage caused by the operation outside of the widths and depths shown in the plans. Damage to traffic due to loose material on milled surface shall be repaired.
- C. Milled material shall be disposed of in a manner approved by the Engineer and in accordance with the specifications.

PART IV - MEASUREMENT**4.1 Measurement**

- A. The quantities of accepted work will be measured in the following units. All measurements will be plan measure except for authorized changes.
 - 1. Mill Existing Asphalt Pavement SY (Square Yard)

PART V - PAYMENT**5.1 Payment**

Payment will be made at the respective unit or lump-sum price listed in the proposal and shall be full compensation for all labor, materials, and equipment necessary to complete the respective unit in place. There will be no separate measurement or payment for any item of work not specifically identified and listed in the proposal, and all such work shall be considered a subsidiary item with all costs pertaining thereto included in the prices for other

items listed in the proposal. At the Engineer's option, partial payment may be made for any lump sum item listed in the proposal, providing that the Contractor is diligently and satisfactorily pursuing full completion of such partially complete item in accordance with the approved job progress schedule.

END OF SECTION

SECTION 32 01 29.13**DAMAGED CONCRETE REMOVAL AND PATCHING****PART I - GENERAL****1.1 DESCRIPTION**

- A. The work specified in this section consists of the removal and repair of damaged concrete on the existing bridges as well as minor repairs on other existing structures. This includes repair of spalling, injection of cracks, etc.

1.2 REFERENCES

<u>Sponsor</u>	<u>Number</u>	<u>Subject</u>
AASHTO	M 6-03	Standard Specifications for Fine Aggregate for Portland Cement Concrete
AASHTO	M 80-87 (2003)	Standard Specifications for Coarse Aggregate for Portland Cement Concrete
AASHTO	M 45-06	Standard Specification for Aggregate for Masonry Mortar
AASHTO	M 85-06	Standard Specification for Portland Cement
AASHTO	M 171-05	Standard Specifications for Sheet Materials for Curing Concrete
AASHTO	T 196-05	Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
AASHTO	T152-05	Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
AASHTO	M 154-06	Standard Specification for Air-Entraining Admixtures for Concrete
AASHTO	M 148-05	Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
AASHTO	M 194-06	Standard Specification for Chemical Admixtures for Concrete
ASTM	C597	Standard Test Method for Pulse Velocity Through Concrete
AASHTO	M 241-05	Standard Specification for Concrete Made by Volumetric Batching and Continuous Mixing
ASTM	C823	Standard Practice for Examination and Sampling of Hardened Concrete in Constructions
ASTM	C876	Standard Test Method for Half-Cell Potentials of Uncoated Reinforcing Steel in Concrete

AASHTO	M 235-03	Standard Specification for Epoxy Resin Adhesives
AASHTO	M 182-05	Standard Specification for Burlap Cloth made from Jute or Kenaf and Cotton Mats
AASHTO	T 259-02	Standard Test Method for Resistance of Concrete to Chloride Ion Penetration
AASHTO	T 260-97 (2005)	Standard Test Method for Sampling and Testing for Chloride Ion in Concrete and Concrete Raw Materials
AWS	D1.4 2005	Structural Welding Code - Reinforcing Steel

1.3 SUBMITTALS

- A. Product data of all proposed materials including material specifications, evidence of successful utilization for similar applications, confirmation of compatibility with other materials, and application procedures.
- B. Applicator qualifications showing successful completion of similar type jobs. Also submit certification from product manufacturers that applicator is sufficiently qualified to perform job.
- C. Applicators schedule of construction.
- D. Staging and screening plans detailing how the applicator will provide adequate access to workers while sufficiently protecting passing rail, automotive and pedestrian traffic from any and all hazards associated with the work. Substantiating design drawings, calculations, and engineering certification shall be provided by the Contractor at KCMO's request.
- E. The Contractor shall submit copies of all required permits and clearances (i.e., authorization from MoDOT, railroad authorization, etc.).

PART II - PRODUCTS

2.1 GENERAL

All products used for repair of existing concrete shall meet the requirements of ACI 546.1R, ACI 318, 2006 International Building Code, and Sections 03 15 16 and 03 31 05 of these specifications. They shall be approved by the manufacturer for the proposed application and have approval of the Engineer prior to ordering for the job.

PART III - EXECUTION

3.1 GENERAL

- A. Prior to ordering any materials or commencing any patching and repair of existing concrete, the Contractor shall obtain written approval of all relevant submittals.
- B. Prior to the commencement of work, staging and screening shall be installed to protect adjacent railroad, motorists and pedestrians from falling debris, dust, etc.
- C. Contractor shall inspect staging and screening on a frequent basis to insure adequacy and shall remedy any inadequacies as required.
- D. Contractor shall clean up and remove from site all demolition debris each day. This cleaning

shall include vacuuming all dust.

- E. The Contract Drawings identify areas to be repaired. This information is provided for informational purposes only. The nature of this work requires that the exact extents of work required needs to be field determined as work progresses as directed and approved by the Engineer.
- F. All work shall comply with ACI 546.1R, ACI 318, 2006 International Building Code, and Sections 03 15 16 and 03 31 05 of these specifications.
- G. The Contractor shall be responsible for providing uniform appearance of all exposed concrete surfaces without blemishes upon completion of job.

3.2 PREPARATION

- A. Clean concrete surfaces of dirt, latence, corrosion, or other contamination; wire brush using water; rinse surface and allow to dry.
- B. Where required patch is less than ½" in depth, remove damaged concrete, thoroughly clean surface and patch using epoxy/sand mix.
- C. Where rebar is exposed, remove all concrete surrounding rebar, thoroughly clean concrete and rebar surfaces, and patch as required.
- D. The Contractor shall take all steps necessary to prevent cutting or otherwise damaging existing reinforcing steel. Any such bars damaged by the Contractor's operations shall be repaired or replaced.
- E. No removal of concrete by hammer methods shall proceed within 40 feet of freshly placed concrete until 48 hours of curing has elapsed, unless otherwise separated by expansion joints or approved by the Engineer.
- F. Sandblast clean the exposed reinforcement steel surfaces and concrete located within the repair cavities.
- G. Following concrete removal operations, the condition of all exposed reinforcing bars shall be inspected by the Engineer. If, in the opinion of the Engineer, the bars are deteriorated by 10% or more of their original cross section area at any point, the Contractor shall remove and replace or supplement these bars as directed by the Engineer.
- H. Flush out cracks and voids with water to remove latence and dirt.
- I. For epoxy injection provide temporary entry ports spaced to accomplish movement of fluids between ports; no deeper than the depth of the crack to be filled or port size diameter no greater than the thickness of the crack. Provide temporary seal at concrete surface to prevent leakage of adhesive.
- J. Any areas of the prepared surface contaminated by oil or other materials detrimental to good bond shall be removed by the Contractor to such depth as may be required. Remove by sandblasting, clean by hydro washing.
- K. Chipping hammers shall be limited to fifteen pound class (nominal).
- L. Concrete saws shall be hand-held electric or gasoline powered.

3.3 REPAIRS

- A. Upon completion of concrete demolition, removal and surface preparation; prior to patching and injection, the Contractor will obtain written approval of the Engineer to proceed with repairs.
- B. Use approved products and procedures for all repair work.

PART IV - MEASUREMENT

- 4.1 Measurement** – No Separate measurement will be made for Work described in this Section.

PART V - PAYMENT

- 5.1 Payment** – No separate payment will be made for damaged concrete removal and patching. All costs pertaining thereto shall be included in the Contract Unit Prices for other items as listed in the Bid Form-Unit Prices.

END OF SECTION

SECTION 32 01 29.16**DELAMINATION REPAIR****PART I - GENERAL****1.1 SUMMARY****A. Description**

This work includes repair of delaminated concrete areas as identified by inspections reports, QA/QC and as specified herein. This work shall be constructed in accordance with these specifications and in conformity with the lines, grades, dimensions and notes shown on the Contract Drawings or presented by the Engineer. The work includes material, equipment, and labor necessary to procure, fabricate, prepare, and install in field the concrete repair.

1.2 REFERENCES

<u>Sponsor</u>	<u>Number</u>	<u>Subject</u>
AASHTO	M 235	Epoxy Resin Adhesives
MoDOT		Performance Data Products Listing
MoDOT		Accepted Product Listing

1.3 SUBMITTALS

- A. Submittals shall be made in accordance with the requirements of the Project Quality Plan, except as modified herein.
- B. Prior to repairing the concrete the product review, data sheets, and repair procedure shall be submitted to the Engineer for review and approval for each repair. Include as needed special mixing procedures and site preparation procedures as applicable. Indicate additional mix ingredients and proportions not provided by the manufacturer such as but not limited to; curing compounds, rebar, coarse aggregate, fine aggregate, and/or any add mixtures.
1. With each mix design, submitting manufacture certifications or laboratory test results including compressive strength at 28 days and mill or manufacturer's certificates attesting to conformance of ingredients with Specifications.
 2. Include the source, brand or characteristic properties of the ingredients need to be verified during the term of the Contract.
- C. Inspection reports for each repair indicating structure and location.

1.4 QUALITY CONTROL

Quality control shall be made in accordance with the approved Project Quality Plan.

1.5 ACCEPTANCE

- A. Rebuild the areas to original shape, \pm 1/8 inch.

- B. Remove and repair if the patching fails to bond.

PART II - PRODUCTS

2.1 MATERIALS

- A. Repair Concrete:
 - 1. Portland Cement Concrete: Class AA (AE). Refer to Section 03 15 16.
 - 2. Cement: Type II. Refer to Section 03 15 16.
 - 3. Aggregate: 3/4 inch maximum.
- B. Patching Concrete:
 - 1. Select from the Performance Data Products Listing (PDPL) maintained by the MODOT Research Division.
 - 2. Only use products for which the manufacturer recommends vertical application.
- C. Substrate Coating: Use a bonding agent or primer recommended by the particular patching concrete manufacturer.
- D. Epoxy Resin Adhesive: Type II. AASHTO M 235.
 - 1. Use a class rating consistent with the application temperature.
 - 2. Select from the Performance Data Products Listing (PDPL) maintained by the MODOT Research Division.
- E. Surface Sealing Material (Penetrating Type): Select from the Accepted Products Listing (APL) maintained by MODOT.
- F. Cement, fly ash, aggregates, and embedments shall be free of calcium chloride.

2.2 MIXER

- A. Use an approved type of small mixer to batch out the repair concrete when specifically approved by the Engineer.

PART III - EXECUTION

3.1 PREPARATION

- A. Locate the repair areas: Sound the items requiring this work and mark the limits of delaminated areas for repair work in the presence of the Engineer.
- B. Remove concrete:
 - 1. Remove all loose materials by dry sweeping.
 - 2. Clean by blowing with compressed air at 90 psi.
 - 3. Make ½ inch deep saw cuts in the sound concrete surrounding the damaged areas.

4. Remove all damaged and shattered concrete.
- C. Cleaning:
1. Remove all loose materials by dry sweeping.
 2. Clean by blowing with compressed air at 90 psi.
 3. Sandblast clean all exposed reinforcing steel and concrete surfaces before placing new concrete.

3.2 INSTALLATION

- A. Form Work
1. Use forms and braces to place new concrete to the original dimensions.
 2. Vibration is required in the forms when the area between forms and existing concrete surface will allow use of vibrators.
- B. Use one type of repair concrete.
- C. Placing concrete when thickness to be placed is less than or equal to 3 inches:
1. Use patching concrete.
 2. Coat the cleaned concrete using the manufacturer's recommended primer.
 3. Place patching concrete in layers not exceeding the manufacturer's recommended application thickness per layer.
 4. Apply the surface sealer recommended by the manufacturer.
 5. Consult the manufacturer's recommendations for finishing.
- D. Placing concrete when thickness to be placed is greater than 3 inches:
1. Apply an epoxy-resin adhesive to the cleaned concrete surface of the repair area before placing the new concrete.
 2. Place the concrete and allow it to cure following the requirements of Section 03 39 00.
 3. After the concrete has properly cured, sandblast the finished concrete surfaces and coat with a non-penetrating type epoxy sealer. Follow the manufacturer's procedure.
- E. Finished surfaces: Provide the look of one color.

PART IV - MEASUREMENT

- 4.1 **Measurement** – No Separate measurement will be made for Work described in this Section.

PART V - PAYMENT

5.1 Payment – No separate payment will be made for delamination repair. All costs pertaining thereto shall be included in the Contract Unit Prices for other items as listed in the Bid Form-Unit Prices.

END OF SECTION

SECTION 32 01 90**OPERATION AND MAINTENANCE OF PLANTING****PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes plant and grass area maintenance including the following:
1. Maintenance service.
 2. Fertilizers.
 3. Pesticides/Herbicides.
- B. Related Sections:
1. Section 32 80 00 "Irrigation" for irrigation.
 2. Section 32 92 00 "Prairie Grasses and Wildflowers" prairie planting, hydroseeding, and erosion-control materials.
 3. Section 32 93 00 "Plants" for trees, shrubs, perennials, ornamental grasses and other plants.

1.3 DEFINITIONS

- A. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.
- B. Pests: Living organisms that occur where they are not desired, or that cause damage to plants, animals, or people. These include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.
- C. Plant; Plants; Plant Material: These terms refer to vegetation in general, including trees, shrubs, ground covers, ornamental grasses, bulbs, corms, tubers, or herbaceous vegetation.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
1. Pesticides and Herbicides: Include product label and manufacturer's application instructions specific to this Project.
- B. LEED Submittals:
1. Product Data for Credits MR 5.1 and 5.2 - Local/Regional Materials:
 - a. Indicate location of manufacturing facility, including name, address, and distance between manufacturing facility and the project site. Provide manufacturer's documentation indicating location where the base materials were extracted, mined, quarried, harvested, etc. and the

distance between this location and the project site. Also include material costs, excluding cost of installation.

- C. Qualification Data: For qualified landscape Maintenance Service Provider. Include list of similar projects completed by Maintenance Service Provider demonstrating Maintenance Service Provider's capabilities and experience. Include project names, addresses, and year completed, and include names and addresses of owners' contact persons.
- D. Product Certificates: For each type of manufactured product, including fertilizers, from manufacturer, and complying with the following:
 - 1. Manufacturer's certified analysis of standard products.
 - 2. Analysis of other materials by a recognized laboratory made according to methods established by the Association of Official Analytical Chemists, where applicable.
- E. Maintenance Instructions: Recommended procedures to be established by Owner for maintenance of plants and prairies during a calendar year. Submit before start of required initial maintenance periods.

1.5 QUALITY ASSURANCE

- A. Maintenance Service Provider Qualifications: A qualified landscape Maintenance Service Provider whose work has resulted in successful plant and prairie establishment of plants.
 - 1. Professional Membership: Maintenance Service Provider shall be a member in good standing of either the Professional Landcare Network or the American Nursery and Landscape Association.
 - 2. Experience: Five years' experience in landscape maintenance in addition to requirements in Division 01 Section "Quality Requirements."
 - 3. Maintenance Service Provider's Field Supervision: Require Maintenance Service Provider to maintain an experienced full-time supervisor on Project site when work is in progress.
 - 4. Personnel Certifications: Maintenance Service Provider's field supervisor shall have certification in the following categories from the Professional Landcare Network:
 - a. Certified Landscape Technician - Exterior, with maintenance and irrigation specialty area(s), designated CLT-Exterior.
 - 5. Maintenance Proximity: Not more than two hours' normal travel time from Maintenance Service Provider's place of business to Project site.
 - 6. Pesticide Applicator: State licensed, commercial.
- B. Pre-Maintenance Conference: Conduct conference at Project site.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of conformance with state and federal laws, as applicable.
- B. Bulk Materials:
 - 1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
 - 2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching

- adjacent properties, water conveyance systems, or walkways.
3. Accompany each delivery of bulk fertilizers with appropriate certificates.

1.7 PROJECT CONDITIONS

- A. Weather Limitations: Proceed with maintenance only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions.

1.8 MAINTENANCE SERVICE

- A. Initial Prairie Maintenance Service: Provide full maintenance by skilled employees of landscape Maintenance Service Provider. Maintain as required in Part 3. Begin maintenance immediately after each area is planted and continue until acceptable prairie is established, but for not less than 1 year from date of Substantial Completion.
- B. Initial Maintenance Service for Trees and Shrubs: Provide maintenance by skilled employees of landscape Maintenance Service Provider. Maintain as required in Part 3. Begin maintenance immediately after plants are installed and continue until plantings are acceptably healthy and well established but for not less than 1 year from date of Substantial Completion.
- C. Initial Maintenance Service for Ground Cover and Other Plants: Provide maintenance by skilled employees of landscape Maintenance Service Provider. Maintain as required in Part 3. Begin maintenance immediately after plants are installed and continue until plantings are acceptably healthy and well established but for not less than 1 year from date of Substantial Completion.
- D. Continuing Maintenance Proposal: From Maintenance Service Provider to Owner, in the form of a standard yearly (or other period) maintenance agreement, starting on date initial maintenance service is concluded. State services, obligations, conditions, and terms for agreement period and for future renewal options.

PART 2 - PRODUCTS

2.1 FERTILIZERS

- A. Slow-Release Organic Fertilizer: Subject to compliance with requirements, products that may be incorporated into the Work include:
 1. Biosol 6-1-3 Natural All Purpose fertilizer.
 2. Sustane 5-2-4 All Natural Granulated Slow Release Nitrogen fertilizer.

2.2 PESTICIDES/HERBICIDES

- A. Pesticide: Registered and approved by EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.
 1. Selection of Pesticide shall be contingent on, but not limited to, the following:
 - a. Identification of specific pest(s) to be prevented, destroyed, repelled, or mitigated.
- B. Pre-Emergent Herbicide (Selective and/or Non-Selective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.

1. Selection of Pre-Emergent Herbicide(s) shall be contingent on, but not limited to, the following:
 - a. Identification of specific weed(s) to be eradicated.
 - b. Identification of growth rate (at the time of application) required for herbicide to be effective, specific to each type of weed.
 - c. Location of weeds (slope, exposure, etc.).
 - d. Hydrology of the area (i.e., limitations due to possible contamination to wetlands, subsurface water sources, etc.).
 - e. Soil type(s).
 - f. Application type (spot versus broadcast).
- C. Post-Emergent Herbicide (Selective and/or Non-Selective): Effective for controlling weed growth that has already germinated.
 1. Selection of Post-Emergent Herbicide(s) shall be contingent on, but limited to, the following:
 - a. Identification of specific weed(s) to be eradicated.
 - b. Identification of growth rate (at the time of application) required for herbicide to be effective, specific to each type of weed.
 - c. Location of weeds (slope, exposure, etc.).
 - d. Hydrology of the area (i.e., limitations due to possible contamination to wetlands, subsurface water sources, etc.).
 - e. Soil type(s).
 - f. Application type (spot versus broadcast).
 - g. Identification of plants to be saved.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities, trees, shrubs, and turf areas, and existing plantings from damage caused by maintenance operations.

3.2 IRRIGATED PRAIRIE MAINTENANCE

- A. Maintain and establish prairie by watering, weeding, mowing, trimming, replanting, and performing other operations as required to establish a healthy, viable prairie. Roll, regrade, and replant bare or eroded areas and remulch. Provide materials and installation the same as those used in the original installation.
 1. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and prairie damaged or lost in areas of subsidence.
 2. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.
 3. Apply treatments as required to keep prairie and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.
 4. Bare areas over 1 square feet in size shall be reseeded and mulched if they fail to establish at least 6 desirable seedlings/sq. ft. (non-irrigated areas) or 12 desirable seedlings/sq. ft. (irrigated areas). The Landscape Architect or Ecologist will direct Contractor on what areas need to be reseeded during establishment inspection approximately 30 days after seeding (June-September).
- B. Watering: Install and maintain piping, hoses, and turf-watering equipment to convey water from sources and to keep seeded areas uniformly moist to a depth of 4 inches (100 mm).

1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch.
 2. Water prairie at a minimum rate of 1/2 inch per week for eight weeks after planting unless rainfall precipitation is adequate.
 3. Areas that are irrigated and are not producing a uniform plant growth within 30 days following first seeding, as determined by establishment inspection, shall be reseeded.
- C. Seeded areas shall be mowed for annual weed control, if so directed by the Landscape Architect, at a height of not less than 3 inch and otherwise maintained until there is an acceptable uniform plant growth. A small tractor or mower shall be used to reduce possible crushing of seedling grasses and rutting of soil.

3.3 TREE AND SHRUB PRUNING

- A. Remove only dead, dying, or broken branches. Do not prune for shape.
- B. Prune, thin, and shape trees, shrubs, and vines according to standard professional horticultural and arboricultural practices. Unless otherwise indicated by Architect, do not cut tree leaders; remove only injured, dying, or dead branches from trees and shrubs; and prune to retain natural character.
- C. Do not apply pruning paint to wounds.

3.4 PLANT MAINTENANCE

- A. Maintain plantings by pruning, cultivating, watering, weeding, fertilizing, mulching, restoring planting saucers, adjusting and repairing tree-stabilization devices, resetting to proper grades or vertical position, and performing other operations as required to establish healthy, viable plantings. Spray or treat as required to keep trees and shrubs free of insects and disease.
- B. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace mulch materials damaged or lost in areas of subsidence.
- C. Apply treatments as required to keep plant materials, planted areas, and soils free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards. Treatments include physical controls such as hosing off foliage, mechanical controls such as traps, and biological control agents.

3.5 PESTICIDE/HERBICIDE APPLICATION

- A. Apply pesticides, herbicides and other chemical products and biological control agents in accordance with requirements of authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.
- B. Pre-Emergent Herbicides (Selective and/or Non-Selective): Apply in accordance with manufacturer's written recommendations.
- C. Post-Emergent Herbicides (Selective and/or Non-Selective): Apply only as necessary to treat already-germinated weeds and in accordance with manufacturer's written recommendations.

3.6 CLEANUP AND PROTECTION

- A. During maintenance operations, keep adjacent paving and construction clean and work area in an orderly condition.
- B. Promptly remove soil and debris created by maintenance work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.
- C. Protect plants from damage due to maintenance operations. Maintain previously installed protection during maintenance periods. Treat, repair, or replace damaged plantings.
- D. Maintain fencing and barricades throughout initial maintenance period and remove after plantings are established.

3.7 DISPOSAL

- A. Remove surplus soil and waste material including excess subsoil, unsuitable soil, trash, and debris and legally dispose of them off Owner's property.

END OF SECTION

SECTION 32 11 00**AGGREGATE BASE COURSE****PART 1 – GENERAL**

1. This section covers the construction of Aggregate Base as shown on the Plans, described in the Contract Documents, or as directed by the OWNER'S REPRESENTATIVE.
2. All the requirements of the Kansas City Metropolitan Chapter of the American Public Works Association (APWA), *Standard Specifications and Design Criteria* apply as amended and supplemented by the Department of Public Works of the City of Kansas City, Missouri (KCMO). Sections of said Specifications will be hereinafter referred to as "APWA-KCMO."
3. Aggregate construction shall conform to APWA-KCMO 2202.
4. **Aggregate Base** shall conform to Missouri Department of Transportation (MoDOT) Standard Specifications for Highway Construction Section 1007.3 Type 5 Aggregate (or Kansas Department of Transportation (KDOT) AB-3 Aggregate).

PART 2 - MATERIALS AND PLACEMENT

1. **Aggregate Base.** Aggregate for base shall consist of crushed stone or sand and gravel. The aggregate shall not contain more than 15 percent deleterious rock and shale. If crushed stone is used, sand may be added only for the purpose of reducing the plasticity index of the fraction passing the No. 40 sieve in the finished product. The fraction passing the No. 40 sieve shall have a plasticity index not to exceed six. Any sand, silt and clay, and any deleterious rock and shale shall be uniformly distributed throughout the material. When sand and gravel aggregate are used, the fraction passing the No. 200 sieve shall be less than one half of that fraction passing the No. 30 sieve. Type 5 (AB-3) aggregate shall conform to the gradation requirements of MoDOT Standard Specifications for Highway Construction Section 1007.3.2 Type 5 (or KDOT Section 1104.2 AB-3).

PART 3 – EXECUTION

None

PART 4 - MEASUREMENT

1. **Aggregate Base.** Aggregate Base shall be measured per ton.

PART 5 - PAYMENT

1. Aggregate Base shall be paid for at the contract unit price for Aggregate Base. All Such payment and price shall constitute full compensation for all labor, material, and equipment necessary to complete the items including material, securing the source, quarrying, excavating, breaking, and hauling the material to the site.

END OF SECTION

SECTION 32 11 00**UNTREATED COMPACTED AGGREGATE**

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required and obtain materials for construction of aggregate base course as outlined for the uses shown on the Drawings and as specified herein.

1.02 RELATED WORK

- A. Submittals are included in Section 01 33 00.
- B. Site preparation is included in Section 31 22 00.
- C. Subgrade Preparation is included in Section 31 23 13.
- D. Portland cement concrete paving is included in Section 32 13 13.

1.03 SUBMITTALS

- A. Submit, in accordance with Section 01 33 00, complete product data for materials specified in this Section.
 - 1. At least fifteen (15) days prior to the placement of any backfill or fill materials, the Contractor shall provide written documentation of the source of the fill and certification that the fill material is clean and in compliance with applicable standards and regulations for each source of fill material.

1.04 REFERENCE STANDARDS

- A. In addition to complying with all pertinent codes and regulations, comply with the referenced or applicable portions of the American Public Works Association Design Criteria and Standard Specifications as revised, adopted, and provided by the director of Kansas City, Missouri Public Works current at the time of bidding.
- B. American Society for Testing and Materials (ASTM)
 - 1. ASTM C88 – Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
 - 2. ASTM C88 – Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate

3. ASTM C131 – Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
4. ASTM C136 – Test Method for Sieve Analysis of Fine and Coarse Aggregates
5. ASTM C142 – Test Method for Clay Lumps and Friable Particles in Aggregates

C. American Association of State and Highway Officials (AASHTO)

1. AASHTO T99 – The Moisture-Density Relations of Soils Using a 5.5-lb. (2.5 kg) Rammer and a 12-in. (305 mm) Drop

D. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 QUALITY ASSURANCE

A. Laboratory Testing

2. At least fifteen (15) days prior to the placement of any backfill or fill materials, the Contractor shall provide written documentation of the source of the fill and certification that the fill material is clean and in compliance with applicable standards and regulations for each source of fill material.

2. The soils testing laboratory will perform:

- a. Grain size analyses (ASTM D422) of samples to determine their suitability for use as backfill or fill material in conformance to the materials requirements specified hereinafter.
- b. Proctor analyses (ASTM D698) to determine the maximum dry densities required for compaction testing as specified elsewhere in the Contract Documents.

3. Test results and determinations of suitability shall be delivered to the Engineer no later than five (5) days prior to the placement of backfill or fill materials.

4. Samples of the aggregate to check gradation may be taken by the Inspector at least once daily. Sampling shall be in accordance with ASTM D 75, and testing shall be in accordance with ASTM C 136 and C 117.

1.06 DELIVERY, STORAGE AND HANDLING

A. If granular fill materials are delivered to the site prior to placement approval, materials shall be stockpiled on site in areas as directed by the Engineer. Provision shall be implemented to minimize surface water

impact on the stockpile. Removal and placement of granular fill material shall be done in a manner to minimize intrusion of soils adjacent to and beneath the stockpile.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. The base course material shall consist of crushed stone aggregate with not more than 1.0% clay lumps and friable particles in accordance with ASTM C 142, and free from vegetable or other deleterious substances.
- B. The abrasion loss shall be no more than 35% when tested in accordance with ASTM C 131. That fraction passing the 1 inch (25.0 mm) sieve and retained on the No. 4 (4.75 mm) sieve shall have a loss not greater than 15% by weighted average at 5 cycles of ASTM C 88 (Magnesium Sulfate) Soundness Test.
- C. That fraction of the material passing the 1-inch (25.0 mm) Sieve and retained on the No. 4 (4.75 mm) Sieve shall contain less than 20% by weight of flat and elongated particles (flat being a ratio of 1 to 3 between thickness and least width and a ratio of 1 to 3 between the least width and length).
- D. The material shall consist of angular particles with no less than 90% of particle count having two or more fractured surfaces. The gradation in percentages by weight passing square mesh sieves shall be in accordance with ASTM C 136 and as follows:

U.S. Standard Square Mesh Sieve	Percent Passing
1-1/4 in (31.5 mm)	100
1 in (25.0 mm)	72-100
3/4 in (19 mm)	60-90
3/8 in (9.5 mm)	43-74
No. 4 (4.75 mm)	28-60
No. 10 (2.00 mm)	16-40
No. 40 (425 um)	3-22
No. 200 (75 um)	0-15

- E. In addition to the above limits, the difference between the "Percent Passing Square Mesh Sieve" of successive sieve sizes shall not exceed 25 percent.
- F. That fraction of the material passing the No. 40 (425 um) sieve shall have a plasticity index not to exceed 8 when tested in accordance with ASTM D 4318.

PART 3 - EXECUTION**3.01 PLACEMENT****A. Subgrade**

1. Prior to placement of base course material the previously prepared subgrade surface shall be cleared of all foreign substances and restored in shape, tolerance and density as specified in Section 31 23 13 entitled "Subgrade Preparation."

B. Material Placement

1. The material shall be uniformly spread in successive layers to such depth that when compacted, the base will have the minimum thickness specified. The contractor may construct the base in any number of layers that he chooses except that in no case shall any individual layer have a compacted thickness of more than 4 inches (10.16 cm). Each layer shall be compacted as hereinafter specified before any succeeding layer is placed.
2. After spreading a layer of material, water in an amount sufficient to insure the desired compaction shall be added and uniformly mixed with the aggregate in a manner to prevent segregation. Excess moisture resulting in runoff shall be avoided. If for any reason, the material and subgrade become too wet to permit satisfactory work, they shall be allowed to dry to a moisture content that will permit satisfactory work.

C. Segregation

1. The material shall meet the required specifications immediately before compaction operations are commenced. If, for any reason, segregation occurs in excess of 10% variation from the gradation required under the above paragraph "Materials" or the materials become contaminated, such segregated or contaminated materials shall be removed and replaced with suitable materials at the expense of the Contractor. The limited segregation of 10% variation will be ascertained by a sieve analysis of a minimum 100 pound (45.36 Kg) sample taken from the in-place base course. However, when crushed stone is used, segregated surface areas may be corrected by adding limestone screenings of such gradation and quantity as required to fill the surface voids and firmly bind the loose material in place. Screenings so used in correcting segregated surface areas will be paid for as a part of the aggregate base material.

D. Compacting

1. Shaping and compacting shall be carried on continuously until a true, even and uniform surface of proper grade and cross-section is obtained, and until the density of the complete base is at least 95% of

maximum density as determined by AASHTO T 99. The proper moisture content shall be maintained by wetting the surface as required during shaping and compacting operations. Final rolling shall be accomplished by use of a self-propelled smooth-wheeled roller.

END OF SECTION 32 11 00

SECTION 32 12 13.19**PRIME COATS****PART I - GENERAL****1.1 SUMMARY**

- A. Description
 - 1. Furnish materials and apply liquid or emulsified asphalt to a prepared subgrade or untreated base course (Prime Coat).
 - 2. Apply blotter materials to absorb excess asphalt as required.

1.2 REFERENCED STANDARDS

<u>Sponsor</u>	<u>Number</u>	<u>Subject</u>
AASHTO	T 27	Sieve Analysis of Fine and Coarse Aggregates
AASHTO	T 201	Kinematic Viscosity of Asphalts

1.3 SUBMITTALS AND INFORMATION TO BE RETAINED

- A. Submittals shall be made in accordance with the requirements of the Project Quality Plan, except as modified herein.
- B. Retain the following:
Certificates and Test Reports.

1.4 QUALITY ASSURANCE/QUALITY CONTROL

Quality assurance/quality control shall be in accordance with the requirements of the Project Quality Plan.

1.5 DELIVERY, STORAGE, AND HANDLING

Materials shall be delivered to the site in an undamaged condition and stored off the ground in a well-drained location, protected from damage, and easily accessible for inspection and handling.

PART II - PRODUCTS**2.1 PRIME COAT MATERIAL**

- A. Prime Coat
Liquid asphalt: AASHTO MC-70 or MC-250
- B. Blotter Material (AASHTO T-27)

Granular materials meeting the following criteria:

Sieve Size	Percent Passing
No. 4	90–100
No. 10	25–80
No. 200	0–15

2.2 TACK COAT MATERIAL

- A. Use CSS-1 H Emulsified Asphalt
- B. In the event that paving fabric is applied, use PG 58-22 or PG 64-22 instead.

PART III - EXECUTION

3.1 CONSTRUCTION

- A. Weather Limitations
 - 1. Do not apply prime coat/tack coat on a wet surface.
 - 2. Do not apply prime coat/tack coat when the surface temperature is below 50 Degrees Fahrenheit.
 - 3. Do not apply prime coat/tack coat when the weather conditions prevent it from adhering properly.
- B. Protection Requirements

Protect all structures (including guardrails, guide posts, etc.) from being spattered or marred.
- C. Surface Preparation
 - 1. Prime Coat
 - a. Shape the surface to the required grade and section.
 - b. Keep the surface free from ruts, corrugations, or other irregularities.
 - c. Compact the surface uniformly.
 - 2. Tack Coat
 - a. Clean the surface of all materials that prevent the tack coat from bonding to the existing surface (e.g. mud, dirt, leaves, etc.)
 - b. Maintain the tack coat until the next course is placed. This must be done the same day the tack coat is applied. Cover all tacked surface areas with surfacing materials.
- D. Application
 - 1. Use a pressure distributor to apply the asphalt in a uniform, continuous spread. Keep the viscosity between 50 and 100 centistokes (AASHTO T-201)

2. Spread blotter material if the asphalt fails to penetrate. Use the quantities required to absorb the excess asphalt.
3. Prime Coat
 - a. Apply a prime coat to all concrete surfaced, including vertical which will come in contact with Hot Mix Asphalt.
 - b. Maintain the prime coat until the next course is placed.
 - c. Keep all traffic off the prime coat until it has cured and dried.
4. Tack Coat
Apply a tack coat to all surfaces, including vertical which will come in contact with Hot Mix Asphalt.

PART IV - MEASUREMENT

- 4.1 Measurement** – No Separate measurement will be made for Work described in this Section.

PART V - PAYMENT

- 5.1 Payment** – No separate payment will be made for prime coats. All costs pertaining thereto shall be included in the Contract Unit Prices for other items as listed in the Bid Form-Unit Prices.

END OF SECTION

SECTION 32 12 16.10**ASPHALT CONCRETE PAVEMENT****PART 1 - GENERAL**

1. This section governs all the work and materials necessary for the construction of asphaltic concrete pavements.
2. All the requirements of the Kansas City Metropolitan Chapter of the American Public Works Association (APWA), *Standard Specifications and Design Criteria* apply as amended and supplemented by the Department of Public Works of the City of Kansas City, Missouri (KCMO). Sections of said Specifications will be hereinafter referred to as "APWA-KCMO."

PART 2 - PRODUCTS

1. Asphaltic concrete mixes shall conform to APWA-KCMO 2205. Base course shall be Type 1-01; surface course and wedging shall be Type 5-01.
2. Pavement edge treatment shall be Type 2-01. Pavement edge treatments will consist of the elimination of pavement edge differentials when the distance between a temporary traffic control device and a pavement removal line/pavement drop-off is less than 6-feet. Wedge slopes shall be constructed and compacted as directed by the engineer.
3. Surface course and pavement edge treatment shall be virgin asphalt.
4. Recycled asphalt may be used for the base course.

PART 3 – EXECUTION

1. All work included in this Section shall conform to APWA-KCMO 2200 and the typical sections included in the plan set.

PART 4 - MEASUREMENT

1. The length and width of the work will be measured to the nearest foot and converted to the nearest 0.1 square yard for payment.

PART 5 - PAYMENT

1. "AC Pavement" will be paid for at the Contract Unit Price as listed in the Bid Form-Unit Prices. Such payment and price shall constitute full compensation for all labor, materials, and equipment necessary to complete the item.

END OF SECTION

SECTION 32 12 16.39**PROFILOGRAPH AND PAVEMENT SMOOTHNESS****PART I - GENERAL****1.1 SUMMARY**

- A. Materials and procedures for smoothness testing of (HMA) Hot Mix Asphalt, Open Graded Surface Course (OGSC), Stone Matrix Asphalt (SMA), and Portland Cement Concrete Pavement (PCCP).
- B. Requirements for 25-foot wheel base, California type Profilograph with electronic data recording, storing, data reduction, and printing capabilities.
- C. Related Sections
 - 1. 32 12 13.19 - Prime Coat/Tack Coat
 - 2. 32 13 13 - Portland Cement Concrete Pavement
 - 3. 32 12 16.10 - Asphalt Concrete Pavement

1.2 REFERENCES

MoDOT Materials Manual of Instruction

1.3 GENERAL REQUIREMENTS

- A. Certify Profilograph operators and equipment through the Missouri Department of Transportation. Engineer verifies certifications.
- B. Comply with project Traffic Control Plan and all applicable safety requirements when performing Profilograph testing.
- C. Contractor Quality Control
 - 1. Comply with requirements identified in Section 32 13 13 and Section 32 12 16.10.
 - 2. Address the following minimum items in the QCP:
 - a. Identify person(s) responsible for managing smoothness issues and monitoring compliance with requirements.
 - b. Identify equipment used to measure and monitor smoothness along with calibration and correlation information.
 - c. Identify personnel responsible for operation of equipment and their qualifications.
 - d. Identify construction methods employed to obtain smoothness, including:
 - 1) Method of grade control for rotomilling and paving operations.
 - 2) Actions taken to prevent paver from stopping and starting, including any use of additional equipment.
 - 3) Placement of manholes outside of projected wheel paths and methods of matching surface elevations and slopes

- e. Identify potential problems that could interfere with meeting pavement surface requirements.
- f. Describe grinding process and operation:
 - 1) Equipment and operators
 - 2) Must-grind layout, grade control, sealing process, etc.
 - 3) Schedule

1.4 ACCEPTANCE

- A. Notify the Engineer in writing a minimum of two working days prior to scheduling KCMO inspection of acceptance testing on the final pavement surface, after all corrective work has been performed.
 - 1. Clearly define the areas to be tested for acceptance in the written notification.
 - 2. Do not perform any work on the final surface after acceptance testing, except as directed by the Engineer.
- B. KCMO evaluates the surface by section, defined as:
 - 1. Traffic lane, 0.1 mile in length, including adjacent shoulder with a design width 8.0 ft or less, meeting the Class I description. (See Table 1)
 - a. Testing consists of a single trace measurement of each wheel path, defined as a continuous parallel line 2.5 ft inside the projected lane lines, of the traffic lane.
 - b. Testing of adjacent shoulder consists of a single trace measurement approximately centered in the shoulder when the design width is 6.0 ft or greater. Do not test shoulders having design widths less than 6.0 ft.
 - c. Determine the Profile Index (PI) by taking the average of all profile traces taken on the section.
 - 2. Shoulder, 0.1 mile in length, with a design width greater than 8.0 ft, meeting the Class I description.
 - a. Testing consists of two profile traces, 2.0 ft inside each edge.
 - b. Determine the Profile Index (PI) by taking the average of profile traces taken on the section.
- C. Begin the initial section(s) at the start of the project. Lay out subsequent sections consecutively to the end of the project.
- D. KCMO does not measure the PI for Class II surfaces.
- E. KCMO evaluates longitudinal and transverse deviations for both Class I and Class II surfaces.
- F. If the final lift of pavement cannot be completed due to seasonal limitations, KCMO evaluates all roadway sections paved through the final lift and evaluates the remaining final lift of pavement upon completion.

PART II - PRODUCTS**2.1 FRAME**

- A. Construction:
 - 1. All welded of light-weight square aluminum tubing in three separate units of the same dimensions in width and within 6 inches in length of each other.
 - 2. Design: reinforced truss.
- B. Length:
 - 1. Effective wheel base of the frame assembly: 25 ft.
 - 2. Overall length with multiple wheel assemblies attached: not to exceed 35 ft.
- C. Frame Connections:
 - 1. Indexed with steel location pins or dowels to prevent misalignment of frame assembly.
 - 2. Secured with quick acting clamps rated at a minimum of 800 lbs each.
- D. Parts: Each of the three frame units manufactured to allow interchangeable replacement of individual units.

2.2 WHEEL SUPPORT ASSEMBLIES

- A. Tubing: All welded, light-weight square aluminum.
- B. Connections: All connection points between wheel assemblies and frame sections secured with quick-acting clamps.
- C. Support wheels: Cast aluminum hubs with ball bearing supported steel axles and cushion rubber tires. Caster wheel assemblies: Ball bearing supported.
- D. Front Wheels: Steerable from the center of the machine.
- E. Rear Wheels: Quick setting manual adjustment to allow for short radius turning, moving laterally, and for trimming to avoid crabbing on superelevations.

2.3 RECORDING WHEEL

Light weight, 24 inch to 26 inch nominal diameter, and heavy duty spokes.

- 1. Tire: pneumatic tube type with non-aggressive tread design.
- 2. Frame: all welded of light-weight square aluminum tubing. Frame pivot points and rotating shafts supported by sealed ball bearings.

2.4 GENERAL MECHANICAL

- A. All exposed steel components anodized, nickel plated, or zinc plated for corrosion protection.
- B. Interchangeable parts.

- C. Capable of being broken down in segments that can fit into the back of a standard pickup truck or van for ease of transport.
- D. Constructed to allow complete assembly in less than 15 minutes without tools.

2.5 AC POWER GENERATING UNIT

- A. Self-contained, capable of delivering 120 VAC at 60Hz.
- B. Mount on the frame with appropriate vibration and shock control hardware.

2.6 MICROCOMPUTER

- A. Control the system by a dedicated on-board microcomputer.
- B. The microcomputer components replaceable and interchangeable with like items from the manufacturer's stock to facilitate controller repairs and provide the following minimum operation characteristics:
 - 1. Processor:
 - a. Minimal 16 bit microprocessor capable of running at a nominal 8 MHz processing speed.
 - b. On-board memory sufficient to store Profile Index (PI) and bump Discrimination software.
 - c. RAM memory sufficient to input control parameters and process project documentation variables at the test site.
 - 2. Displacement Transducer Interface:
 - a. Contains an analog to digital converter compatible with the operating characteristics of the microprocessor.
 - b. Include signal conditioning for analog filtering and scaling.
 - c. Overall resolution for displacement transducer less than or equal to 0.004 inches.
 - 3. Odometer Transducer Interface: Provides digital logic to encode positive or negative signals to microprocessor.
 - 4. Clock:
 - a. Provides time and calendar functions to microprocessor unit automatically.
 - b. Independent battery power required to avoid documentation errors and input data losses caused by on-board power shut downs.

2.7 TRANSDUCERS

Rated to withstand shock, vibration, dust, and extremes of humidity. Operational from -30 degrees C to 100 degrees C.

- 1. Vertical Displacement Transducer: Resolution of 0.01 inches.
- 2. Odometer: horizontal resolution of 0.39 inches and operational in either an incrementing or decrementing mode.

3. Temperature transducer: Accurate to 1 degree C.

2.8 PRINTER/PLOTTER

- A. Compatible with and provide suitable interfaces with the microprocessor.
- B. The data acceptance (baud rate) and buffer storage capacity: adequate to fully register, plot, and accept data from a 4 mph operational run without excessive wait states.
- C. Dot matrix mechanism (if applicable): print bar resolution of 100 dots per inch with a row resolution of 200 rows per inch.

2.9 OPERATOR CONTROL PANEL

- A. Located within easy access of the operator and in a location on the profilograph that does not hinder other operational functions or line of sight to testing path.
- B. Control panel with a digital display, data input keyboard, observable indicators, (video or screen) and operator actuated control switches.
- C. Parameters entered, displayed, and printed as follows (all numeric):
 1. Time
 2. Date
 3. Region, route and pavement
 4. Pass number
 5. Beginning Station
 6. Ending Station
 7. Odometer
 8. Blanking band width
 9. Bump height
 10. Bump width
 11. Event marker

2.10 REPORTING REQUIREMENTS

- A. Determine Profile Index, documentation, reports, outputs, or example, as specified. MoDOT Specifications.
- B. Set preprogrammed or operator entered scaling or sensitivity factors at a sensitivity level that to correlate with KCMO profilographs.
- C. Include the following documentation supplied with the Profilograph system:
 1. Operator's Manual.
 2. Wiring Diagrams.
 3. Industry standard part number or name and model numbers for complete subsystems.

PART III - EXECUTION**3.1 HMA, SMA, AND OGSC**

- A. Construction Requirements
 - 1. Construct finished pavement to meet the surface requirements in Table 1.
 - 2. Identify defects exceeding the limits in Table 1 and correct prior to acceptance testing.
 - a. Analyze the profile using 0.2 inch blanking band.
 - b. Correct defects across the entire width of the traffic lane or shoulder either by grinding with a device approved by the Engineer, or by milling and filling as directed by the Engineer.
 - c. Re-profile for correction verification prior to acceptance testing.
 - 3. Correct transverse defects where the pavement surface varies more than 1/8 inch from the lower edge of a 10 foot straightedge placed perpendicular to the centerline of the roadway.
 - 4. Seal ground areas with asphalt tack coat.
 - a. Use a tack coat application rate between 0.07 and 0.14 gal/yd².
 - 5. KCMO inspects acceptance testing prior to the placement of Chip Seal Coat, when applicable.
- B. Incentive/Disincentive – HMA
 - 1. Incentive/Disincentive applies only to Class I surfaces for each pavement section defined in this Section, Article 1.4, Acceptance, paragraph B.
 - a. Incentive/Disincentive is calculated according to Table 2, with partial sections prorated based on length.
 - b. Incentive/Disincentive does not apply to HMA surfaces on projects requiring OGSC or SMA.
 - c. Any section requiring grinding exceeding 20 yd² does not qualify for incentive. Disincentive remains applicable for sections where grinding exceeds 20 yd².
 - 2. Any section still requiring corrective work that is identified at the time of acceptance testing results in loss of incentive for the section. Disincentives remain applicable and are based on PI obtained at the time of acceptance testing.
 - 3. Failure to correct defects, identified at the time of acceptance testing, within 14 calendar days after notification by the Engineer results in liquidated damages assessed at \$100.00 per day after 14 calendar days per each section needing corrective work.
 - a. Liquidated damages may be waived by the Engineer if it is determined to be in the best interests of the Department to defer corrective work.
- C. Incentive/Disincentive - OGSC and SMA Surfaces

1. Incentive/Disincentive applies only to Class I surfaces for each pavement section defined in this Section, article 1.4, Acceptance.
 - a. Incentive/Disincentive is calculated according to Table 3, with partial sections prorated based on length.
2. Any section requiring grinding exceeding 20 yd² or any section still requiring corrective work that is identified at the time of acceptance testing results in a disincentive of \$1000.00 per section
3. Failure to correct defects, identified at the time of acceptance testing, within 14 calendar days after notification by the Engineer results in liquidated damages assessed at \$100.00 per day per each section needing corrective work.
 - a. Liquidated damages may be waived by the Engineer if it is determined to be in the best interests of the Department to defer corrective work.

3.2 PORTLAND CEMENT CONCRETE PAVEMENT (PCCP)

A. Construction Requirements

1. Construct finished pavement to meet surface requirements listed in Table 1.
2. Identify defects exceeding the limits in Table 1 and correct prior to acceptance testing.
 - a. Analyze the profile using 0.2 inch blanking band.
3. Correct defects across the entire width of the traffic lane or shoulder by grinding with a device approved by the Engineer.
 - a. Re-profile for correction verification prior to acceptance testing.
4. Correct transverse defects where the pavement surface varies more than 1/8 inch from the lower edge of a 10 foot straightedge placed perpendicular to the centerline of the roadway.

B. Incentive/Disincentive – PCCP

1. Incentive/Disincentive applies only to Class I surfaces for each pavement section defined in this Section, article 1.4, Acceptance, paragraph B.
 - a. Incentive/Disincentive is calculated according to Table 4, with partial sections prorated based on length.
2. Any section requiring grinding exceeding 20 yd² does not qualify for incentive.
3. Any section still requiring corrective work that is identified at the time of acceptance testing results in loss of incentive for the section. Disincentives remain applicable and are based on PI obtained at the time of acceptance testing.
4. Failure to correct defects, identified at the time of acceptance testing, within 14 calendar days after notification by the Engineer results in liquidated damages assessed at \$100.00 per day per each section needing corrective work
 - a. Liquidated damages may be waived by the Engineer if it is determined to be in the best interests of the Department to defer corrective work.

Table 1 Surface Requirements				
Pavement Category	Class 1 Surface		Class II Surface	
	Section PI	Profile Deviation	Section PI	Profile Deviation
Category	in/mi	in/25ft	in/mi	in/25ft
1	5	0.3	N/A	0.3
2	7	0.3	N/A	0.3
Category 1	National Highway System and Truck Routes (See Section 02741, Table 11) and all other routes with surfaces having three or more opportunities for improving the ride.*			
Category 2	All other routes incorporating single lift overlays with not more than two opportunities for improving the ride.*			
Class I	Surfaces consist of all through traffic and climbing lanes, passing lanes, acceleration and deceleration lanes, shoulders, ramps and turn lanes longer than 1000 ft, including bridges and bridge approach slabs with final riding surfaces placed on the contract. Excluded are horizontal curves having a centerline radius of curvature less than 900 ft and areas within the superelevation transitions to these short radius curves.			
Class II	Surfaces consist of all tapers, road approaches, mainline pavement sections with posted regulatory speeds less than 35 MPH, pavement within 15 ft of bridge decks and approach slabs not paved as part of the project, pavement to a point 50 ft beyond the paving limits of the project and all other surfaces not included in Class 1 and surfaces excluded due to horizontal curves.			

*Each opportunity to improve the ride is one of the following: Placing a gravel or treated base course, OGSC, SMA, rotomilling, cold recycling, and each lift of paving. Leveling is not considered as an opportunity to improve the ride.

Table 2 HMA	
Category	Incentive/Disincentive per Section
1	\$60 x [(Required in/mi) - (PI)]
2	\$30 x [(Required in/mi) - (PI)]

Table 3 OGSC & SMA	
Category	Incentive/Disincentive per Section
1	\$150 x [(Required in/mi) - (PI)]
2	\$100 x [(Required in/mi) - (PI)]

Table 4 PCCP	
Category	Incentive/Disincentive per Section
1	$\$200 \times [(\text{Required in/mi}) - (\text{PI})]$
2	$\$125 \times [(\text{Required in/mi}) - (\text{PI})]$

PART IV - MEASUREMENT

4.1 Measurement – No Separate measurement will be made for Work described in this Section.

PART V - PAYMENT

5.1 Payment – No separate payment will be made for this Work. All costs pertaining thereto shall be included in the Contract Unit Prices for other items as listed in the Bid Form-Unit Prices.

END OF SECTION

SECTION 32 12 16.50**TEMPORARY SURFACING****PART 1 - GENERAL**

1. This section governs all the work and materials necessary for the construction of temporary surfaces.
2. All the requirements of the Kansas City Metropolitan Chapter of the American Public Works Association (APWA), *Standard Specifications and Design Criteria* apply as amended and supplemented by the Department of Public Works of the City of Kansas City, Missouri (KCMO). Sections of said Specifications will be hereinafter referred to as "APWA-KCMO."
3. All work included in this Section shall conform to APWA-KCMO 2200.
4. Temporary pavement mix shall conform to APWA-KCMO 2205 Type 3-01.
5. Temporary aggregate surfacing shall conform to Missouri Department of Transportation (MoDOT) Standard Specifications for Highway Construction Section 1006 Aggregate for Surfacing.
6. Recycled asphalt may be used for temporary pavement.

PARTS 2 AND 3 - MATERIALS AND PLACEMENT

1. **Temporary Aggregate Surfacing.** Aggregate for surfacing shall be composed of durable particles of durable particles of rock. When tested in accordance with AASHTO T 96, the wear should not exceed 60 percent. Temporary aggregate surfacing shall conform to the gradation requirements of MoDOT Standard Specifications for Highway Construction Sections 1006.2 and 1006.3.

PART 4 - MEASUREMENT

1. The length and width of the work will be measured to the nearest foot and converted to the nearest 0.1 square yard for payment.

PART 5 - PAYMENT

1. "Type 3 Asphalt for Temporary Surfacing" will be paid for at the Contract Unit Price as listed in the Bid Form-Unit Prices. Such payment and price shall constitute full compensation for all labor, materials, and equipment necessary to complete the item. No separate payment will be made for removing or disposing the material from the site.
2. "Aggregate for Temporary Surface". 6-in. MO Type 5 Aggregate Base shall be paid for at the Contract Unit Price as listed in the Bid Form-Unit Prices. All Such payment and price shall constitute full compensation for all labor, material, and equipment necessary to complete the items including material, securing the source, quarrying, excavating, breaking, hauling the material to the site, and removing and disposing the material from the site.

END OF SECTION

SECTION 32 13 13**PORTLAND CEMENT CONCRETE PAVEMENT**

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. Furnish the necessary equipment, labor and materials required and perform all work in connection with the construction of concrete pavement as shown on the Drawings and as specified at the time of bidding in American Public Works Association Standard Specifications and Design Criteria Section 2200 as revised, adopted, and provided by the Director of Kansas City, Missouri Public Works.

1.02 REFERENCE STANDARDS

- A. In addition to complying with all pertinent codes and regulations, comply with the referenced or applicable portions of the American Public Works Association Standard Specifications and Design Criteria, and the Kansas City, Missouri Standards and Specifications for Water Main Extensions and Relocations available at the time of bidding.
- B. The following standards are referenced directly in this section. The latest version of these standards shall be used.

ASTM:

- A 185 Standard Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement
- A 615 Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
- C 1116 Standard Specification for Fiber-Reinforced Concrete and Shotcrete
- C 1315 Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete
- C 1399 Test Method for Obtaining Average Residual-Strength of Fiber-Reinforced Concrete
- D 1751 Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
- D 1752 Standard Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction

- D 2628 Standard Specification for Preformed Polychloroprene Elastomeric Joint Seals for Concrete Pavements
- D 2835 Standard Specification for Lubricant for Installation of Preformed Compression Seals in Concrete Pavements
- D 3405 Standard Specification for Joint Sealants, Hot-Applied, for Concrete and Asphalt Pavements
- D 3406 Standard Specification for Joint Sealant, Hot-Applied, Elastomeric-Type, for Portland Cement Concrete Pavements
- E 965 Test Method for Measuring Surface Macrotexture Depth Using a Sand Volumetric Technique

AASHTO:

- M 213 Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
- M 220 Preformed Polychloroprene Elastomeric Joint Seals for Concrete Pavements
- M 282 Joint Sealants, Hot-Poured, Elastomeric Type, for Portland Cement Concrete Pavements
- M 301 Joint Sealants, Hot-Poured, for Concrete and Asphalt Pavements

MCIB

Section 1 Concrete Materials

Section 2 Outdoor Concrete Exposed to Freezing and Thawing

Section 3 Concrete Mix Design Tables

PART 2 - PRODUCTS

2.01 MATERIALS

- A. All products shall be as specified in the American Public Works Association Standard Specifications and Design Criteria APWA Section 2200 as revised, adopted, and provided by the Director of Kansas City, Missouri Public Works.

2.02 CONCRETE CONTROL AND QUALITY

- A. The current editions of the "Bulletins" and Approved Sections of the "Standard Concrete Specifications" issued by the Mid-West Concrete Industry Board, Inc. (MCIB) are made a part hereof by reference. However, when the provisions of this Specification differ from the provisions of such "Bulletins" and "Sections" the provisions of this Specification shall govern.

2.03 CONCRETE

- A. Concrete shall conform to MCIB Section 1 shall be MCIB Mix No. A658-1-2-.365 or No. WA561-1-2- 0.410 or approved equal. All coarse aggregate shall meet the requirements of MCIB section 1 except that it shall meet the following gradation:

Coarse Aggregate Gradation Limits, % Passing

Nominal Maximum Size	1"	¾"	½"
Sieve Size			
1½"	100		
1"	90-97	100	
¾"	62-82	90-97	100
½"	25-60	45-70	80-97
3/8"	16-44	20-55	40-70
No. 4	0-10	0-10	0-15
No. 8	0-5	0-5	0-5

- B. If Fly Ash is to be substituted for cement in the production of concrete, it shall be in accordance with APWA Subsection 2212 – Fly Ash Concrete.
- C. A mix design, for all concrete mixes to be used, shall be submitted to the Engineer for review a minimum of 14 days before use and be approved prior to placement. The mix design shall contain the following information as a minimum:
1. Mix design designation required by project
 2. Project name, location, project number and date
 3. Name and location of ready mix plant or plants
 4. List the source and type of all materials from each plant supplying mix
 5. CA and FA Sieve Analysis and quality checks from each plant supplying mix. CA-Ledge, quarry or mine name and location. FA-Sand plant name, location and source (MO or Kaw River)
 6. Cement chemical analysis
 7. Certifications on admixtures
 8. Specific gravity of all materials
 9. All materials tests and certifications shall be performed no more than six months prior to the placement of any concrete mix
 10. The mix design shall be based on one cubic yard of concrete or one

cubic meter if required

11. The mix design shall contain the weight and volume of each mix component (S.S.D.)
12. The results of 7-day and 28-day compressive strengths shall be submitted when required
13. Special requirements for fly ash concrete mixes
14. Certification of cement and aggregate scales calibration date calibrated and company (performed yearly)
15. On bridge deck pours the concrete shall be supplied from only one plant

2.04 REINFORCEMENT

A. Bars

1. Bars shall conform to ASTM A 615.

B. Welded Steel Wire

1. Welded steel wire fabric shall conform to ASTM A 185.

C. Supporting Elements

1. Representative samples of supporting elements shall be submitted and approved by the Engineer prior to their use in the project.

D. Fibers

1. Where required, fibers shall be applied at the rate of 3 pounds per cubic yard (1.8 kg per cubic meter) of concrete. Fibers for concrete reinforcement shall be composed of only 100% virgin homopolymer polypropylene, fibrillated and graded. Fibers shall contain no reprocessed olefin materials, and shall be specifically manufactured to an optimum gradation for use as secondary concrete reinforcement, meeting the requirements of ASTM C 1116, Type III, 4.1.3, and ASTM C 1116 Performance Level 1, and a minimum residual strength of 30 psi per ASTM C 1399, average of 4 beams sampled at the point of discharge (or when appropriate, the point of placement.)

2.05 ISOLATION JOINT FILLERS

- A. Isolation joint fillers shall conform to ASTM D 1752 or D7174.

2.06 JOINT SEALING COMPOUNDS

- A. Joint sealing compounds shall conform to the standards for the type of sealant specified as listed in the following table:

Joint Seals and Sealants	AASHTO	ASTM
Hot-poured, Polymeric Asphalt Based	M 301	D3405
Hot-poured, Elastomeric-Type	M 282	D3406
Preformed Polychloroprene Elastomeric	M 220	D2628
Lubricant for Installation of Preformed Seal	-	D2835
Preformed Expansion Joint Filler	M 213	D1751

2.07 CURING MEMBRANE

- A. All material to be used or employed in curing Portland Cement Concrete must be approved by the Engineer prior to its use. It shall be of the liquid membrane type and shall conform to ASTM C 1315, Type II, Class A.

PART 3 - EXECUTION

3.01 CONSTRUCTION DETAILS

- A. Portland Cement Concrete pavement shall be constructed to the configuration, and to the lines and grades shown on the plans.

B. Grading and Subgrade Preparation

1. All excavation or embankment required shall be as defined in Sections 31 22 00 and 31 23 13 entitled "Site Preparation and Grading" and "Subgrade Preparation." If areas of the subgrade are below the lines and grades shown on the plans, they shall be brought to the proper line and grade by one of the following:
 - a. Additional fill material placed in accordance with Sections 31 22 00 and 31 23 13.
 - b. Areas may be filled with Granular Fill conforming to Sections 32 11 00.
 - c. Areas may be filled with additional thickness of Portland Cement Concrete Pavement.

C. Forms

1. All forms shall be in good condition, clean, and free from imperfections. Each form shall not vary more than 1/4 inch in horizontal and vertical alignment for each 10 feet of length.
2. Material & Size
 - a. Forms shall be made of metal and shall have a height equal to or greater than the prescribed edge thickness of the pavement slab.

3. Strength

- a. Forms shall be of such cross-section and strength, and so secured as to resist the pressure of the concrete when struck off, vibrated, and finished, and the impact and vibration of any equipment which they may support.

4. Installation

- a. Forms shall be set true to line and grade, supported through their length and, joined neatly in such a manner that the joints are free from movement in any direction.

5. Preparation

- a. Forms shall be cleaned and lubricated prior to each use and shall be so designed to permit their removal without damage to the new concrete.

3.02 JOINTS

- A. Generally joints shall be formed at right angles to the true alignment of the pavement and to the depths and configuration specified by the appropriate standard or as modified by the plans and specifications.

1. Isolation Joints

- a. Isolation joints shall be placed at all locations where shown on the plans and standards or as directed by the Engineer.
- b. Isolation joints shall extend the entire width of the pavement and from the subgrade to one inch below the surface of the pavement or the material will have a suitable tear strip provided to allow for the application of the joint sealer.
- c. Under no circumstances shall any concrete be left across the isolation joint at any point.
- d. Material: Isolation joints shall be formed by a one piece, one inch thick preformed joint filler cut to the configuration of the correct pavement section.
- e. Stability: Isolation joints shall be secured in such a manner that they will not be disturbed during the placement, consolidation and finishing of the concrete.

- f. Dowels: If isolation joints are to be equipped with dowels they shall be of the size and type specified, and shall be firmly supported in place, by means of a dowel basket which shall remain in place. One half of each dowel shall be lightly painted or greased with a product approved by the engineer.

B. Contraction Joints

1. Contraction joints shall be placed where indicated and to the depth indicated by the plans, specifications and standards.
2. Contraction joints shall be sawed.
3. When sawing joints, the contractor shall begin as soon as the concrete hardens sufficiently to prevent excessive raveling along the saw cut and shall finish before conditions induce uncontrolled cracks, regardless of the time or weather. The longitudinal contraction joints shall be sawed immediately after sawing transverse joints. When joint sealing backup material is specified with sawed joints, the first stage, which provides a relief cut shall be approximately 1/8 inch wide, and shall be to plan depth. The second stage which widens the joints to allow the insertion of joint sealing backup material to plan depth shall not be performed until the concrete is at least 48 hours old, and shall be delayed longer when the sawing causes raveling of the concrete. If second stage sawing is performed prior to the completion of the curing period, the contractor shall maintain the cure by use of curing tapes, plastic devices, or other materials approved by the engineer.
4. For Portland Cement concrete pavements, sawed contraction joints shall be one-third the thickness of the slab (minimum).
5. Dowels. If contraction joints are to be equipped with dowels they shall be of the size and type specified and shall be firmly supported in place and accurately aligned parallel to the pavement line and grade with an allowable tolerance of 1/8 inch.

C. Longitudinal and Construction Joints

1. Longitudinal joints or construction joints shall be placed as shown on the plans or where the Contractor's construction procedure may require them to be placed. Longitudinal construction joints (joints between construction lanes) shall be keyed or tied joints of the dimensions shown on the plans or standards.

D. Transverse Construction joints

1. Transverse construction joints of the type shown on the plans or standards shall be placed wherever concrete placement is suspended for more than 30 minutes.

E. Tiebars

1. Tiebars shall be of deformed steel of the dimensions specified by the plans or standards. Tiebars shall be installed at the specified spacing and firmly secured so as not to be disturbed by the construction procedure.

3.03 PLACING, FINISHING, CURING, AND PROTECTION

- A. Concrete shall be furnished in quantities required for immediate use and shall be placed in accordance with the requirements of MCIB Concrete Pavement. Prior to commencing construction, the contractor shall furnish a concrete delivery plan which includes at a minimum the number of trucks which will be dedicated to the project, the location of the concrete plant, the route and distance from the plant to the job site, and the anticipated rate of concrete usage. It is essential that concrete be delivered in sufficient quantities to prevent stoppage of the paving operation.

B. Concrete Placement

1. The concrete shall be deposited on the subgrade to the required depth and width of the construction lane in successive batches and in a continuous operation without the use of intermediate forms or bulkheads. The subgrade shall be moistened prior to the placement of concrete. The concrete shall be placed as uniformly as possible in order to minimize the amount of additional spreading necessary. While being placed, the concrete shall be vibrated and compacted with suitable tools so that the formation of voids or honeycomb pockets is prevented.
2. The concrete shall be well vibrated and tamped against the forms and along all joints. Care shall be taken in the distribution of the concrete to deposit a sufficient volume along the outside form lines so that the curb section can be consolidated and finished simultaneously with the slab.
3. No concrete shall be placed around manholes or other structures until they have been brought to the required grade, alignment, and cross slope.
4. Concrete shall not be allowed to extrude below the forms.

C. Concrete Finishing Methods

1. The pavement shall be struck off and consolidated with a mechanical finishing machine. Hand-finishing methods may be used for small or irregular areas. Furnish paving and finishing equipment applicable to the type of construction as follows:

2. Slip-form Machines
 - a. Furnish slip-form machines capable of spreading, consolidating, screening, and float finishing the freshly placed concrete in one pass to provide a dense and homogeneous pavement with minimal hand finishing.
3. Self-Propelled Form-Riding Machines
 - a. Furnish mechanical, self-propelled spreading and finishing machines capable of consolidation and finishing the concrete with minimal hand finishing. Do not use machines that displace the fixed side forms.
4. Manual Fixed-Form Paving Machines
 - a. Furnish spreading and finishing machines capable of consolidating and finishing the concrete with minimal hand finishing.
5. Hand Methods
 - a. When finishing by hand methods, concrete shall be consolidated by use of vibrating units operating in the concrete. Unless the vibrating apparatus is such that the full width of concrete is consolidated in a single passage, a definite system or pattern shall be used in the operation of the vibrator so the full width of concrete in each linear foot of lane will receive adequate and uniform consolidation. The system and methods of vibrating shall be subject to approval of the Engineer. Vibrating equipment shall, under no circumstances, be used as a tool for moving concrete laterally on the grade.

D. Concrete Finishing

1. Floating
 - a. All surfaces shall be consolidated and floated after strike-off prior to final surface finish.
2. Surface Tolerance
 - a. After the longitudinal floating has been completed and the excess water has been removed, and while the concrete is still plastic, the slab shall be tested for trueness with a highway straightedge. The highway straightedge shall be held in successive positions parallel to the road center-line in contact with the surface and the whole area worked from one side of the slab to the other as necessary. Advancement along the pavement shall be in successive stages of not more than one half the length of the highway straightedge. Any depressions found shall be immediately filled with freshly

mixed concrete, struck off, consolidated, and refinished. Check surface longitudinally while concrete is still plastic; correct any surface deviations greater than 1/8 inch in 10 feet. Round edges of pavement to 1/8 inch radius.

3. Edging

- a. Before final finishing is completed and before the concrete has taken its initial set, the edges of the slab and curb shall be finished to the radius shown on the plans or standards by the paving equipment, or with hand edging tools.

4. Final Surface Finish

a. Dragged Surface Treatment

- i. Astroturf or burlap shall be dragged longitudinally over the finished surface to produce a tight, uniform, textured surface, and the edges shall be rounded in a workmanlike manner for roadways with a design speed of 45 MPH or to be posted 45 MPH or less. The texture achieved by the astroturf or burlap drag shall be tested by the Contractor in accordance with ASTM E 965, "Test Method for Measuring Surface Macrotexture Depth Using a Sand Volumetric Technique", to ensure the texture is adequate for skid resistance when this surface treatment is used for roadways to be posted 50 MPH or more. Test locations will be determined by the engineer. The results of ASTM E 965 shall show an average texture depth of any lot, as defined below, shall have a minimum value of 0.032 inch. Any lot showing an average of less than 0.032 inch but equal to or greater than 0.024 inch will be accepted as substantial compliance but the contractor shall amend their operation to achieve the required 0.032 inch minimum depth. (It is not the intention of this tolerance to allow the contractor to continuously pave with an average texture depth of less than 0.032 inch. Any lot showing an average texture depth of less than 0.024 inch shall require diamond grinding of the pavement represented by this lot to attain the necessary texture. Any individual test showing a texture depth of less than 0.020 inch shall require diamond grinding of the pavement represented by this lot to attain the necessary texture. Limits of any failing individual test shall be determined by running additional tests at 100 foot intervals before and after the failing test location. All testing of the surface texture shall be completed no later than the day following pavement placement.

b. Groove Treatment

- i. Unless otherwise specified the texture surface of travel lanes of pavement shall be given a suitable transverse or

longitudinal grooving, or a dragged surface treatment as described in paragraph a for roadways to be posted at 50 MPH or more. If grooving is required, surface grooving shall be done with a mechanical device such as a wire broom or comb or by hand. The broom or comb shall have a single row of spring steel tines, rectangular in cross section, 1/8 inch to 3/16 inch wide; spaced on 3/4 inch centers of sufficient length, thickness, and resilience to form grooves to a depth of a minimum of 1/8 inch to a maximum of approximately 3/16 inch in the plastic concrete. This operation shall be done at such time and in such manner that the desired surface texture will be achieved while minimizing displacement of the larger aggregate particles and before the surface permanently sets. Where abutting pavement is to be placed, the grooving should extend as close to the edge as possible without damaging the edge. If abutting pavement is not to be placed, the 6 inch area nearest the edge or 1 foot from the face of the curb is not required to be grooved. For small or irregular areas or during equipment breakdown, grooving may be done by hand methods.

5. Curing

- a. As soon as practical after the concrete is finished it shall be cured with one of the acceptable methods. Curing shall conform to the requirements of MCIB Standard Concrete Specifications except water proof paper or polyethylene sheeting shall not be acceptable as curing methods for concrete pavement. If a liquid curing membrane is used, it shall be applied in accordance to the manufacturer's directions.
- b. Method of Applying Curing Membrane
 - i. A nozzle producing a uniform fan pattern will be used on all spray equipment when applying the liquid curing membrane. The curing compound should be applied immediately after final finishing, and before the loss of all free water on the surface of the concrete. Normally one smooth, even coat shall be applied at a rate of 150 to 200 square feet per gallon, but two coats may be necessary to ensure complete coverage and effective protection. Second coats should be applied at right angles to the first.
- c. Curing Formed Surfaces
 - i. If the forms are removed from finished concrete pavement within a period of 72 hours or if a slip form paving machine has been used, these surfaces shall also be cured. Curing membrane damaged by joint sawing operations shall be repaired by the Contractor as directed by the Engineer.

6. Protection

- a. The Contractor shall, at his own expense, protect the concrete work against damage or defacement of any kind until it has been accepted by the Engineer.
- b. All vehicular traffic shall be prohibited from using the new concrete pavement until it has attained strength in accordance with the following table:

Slab Thickness	Strength for Opening to Traffic psi	
	Compressive	3rd-Point Flexural
All UTW	2000	300
6.0"	3600	540
7.0"	2700	410
8.0"	2150	340
9.0"	2000	300
10"+	2000	300

- c. Concrete pavement that is not acceptable to the Engineer because of damage or defacement, shall be removed and replaced, or repaired to the satisfaction of the Engineer, at the expense of the Contractor.

7. Diamond Grinding

- a. Grind the riding surface to reduce or eliminate the irregularities.
- b. Use a self-propelled grinding machine with diamond blades mounted on a multi-blade arbor. Avoid using equipment that causes excessive ravels, aggregate fractures, or spalls. Provide uniform texture the full width of the lane.
- c. Transverse grooving will not be required.
- d. Use vacuum equipment or other continuous methods to remove grinding slurry and residue. Prevent the grinding slurry from flowing across lanes being used by traffic.
- e. After corrections have been made to the riding surface, test the pavement for smoothness using the same technique used to determine smoothness originally.
- f. Where smoothness is determined through the use of a profilograph, run two traces in each lane that has been corrected. Run one trace three feet from the longitudinal joint between the lanes and another trace three feet from the shoulder or curb edge of the lane. Assure that the profilograph testing and evaluation is performed by a trained and certified operator. Within two days

3.04 BACKFILL

- A. A minimum of 24 hours shall elapse before forms are removed and 5 days shall elapse or the concrete must have attained 75% of its 28 day compressive strength before pavement is backfilled unless otherwise approved by the Engineer.
- B. Backfill shall be accomplished in accordance with Sections 31 22 00 and 31 23 13 entitled "Site Preparation and Grading" and "Subgrade Preparation."
- C. The Contractor shall be responsible for the repair of any existing street pavement damaged by the construction to the satisfaction of the Engineer.

3.05 JOINT SEALING AND CLEAN-UP

- A. All joints shall be sealed with an approved joint sealer meeting the requirements of the products section applied in accordance with the manufacturer's directions within 7 days of the placement of the concrete and prior to the opening of the pavement to traffic.
- B. The Contractor shall be responsible for the removal of excess dirt, rock, broken concrete, concrete splatters and overspray from the area of the construction.

3.06 INTEGRAL CURB

- A. Integral curbs shall be required along the edges of all street pavements as indicated on the plans, or standards, except at such locations as the Engineer may direct. The integral curb shall be constructed during or immediately following the finishing operation unless otherwise shown on the plans. Special care shall be taken so that the curb construction does not lag behind the pavement construction and form a "Cold joint."
- B. Steel curb forms or integral slipforming shall be required to form the backs of all curbs except where impractical because of small radii street returns or other special sections. Curbs shall be formed to the cross section as shown on the drawings with a mule; or templates supported on the side forms and with a float not less than four feet in length.
- C. The finished surface of the curb and gutter shall be checked for no more than ¼ inch deviation by the use of a 10 foot straightedge and corrected if necessary. Where grades are flat and while the concrete is still plastic, the drainage of the gutter should be checked with a 4 ft. carpenter's level.

3.07 REPAIRING DEFECTS

- A. Repair defects in conformance with the following. Do not begin corrective work until after submitting a plan and receiving the Engineer's approval for repair methods.

Defect Type	Defect Direction	Defect Location	Description	Repair Procedure	Alternate Procedure
Plastic Shrinkage Crack	Any	Anywhere	Only partially Penetrates depth	Do nothing	Fill with HMWM2
Uncontrolled Crack	Transverse	Mid-slab	Full-depth	Saw and seal Crack	LTR3
Uncontrolled Crack	Transverse	Crosses or ends at transverse joint	Full-depth	Saw and seal the crack; Epoxy uncracked joint	
Uncontrolled Crack	Transverse	Relatively parallel and within 1.5 m of joint	Full-depth	Saw and seal the crack; Seal joint	FDR4 to replace crack and joint
Saw cut or Uncontrolled Crack	Transverse	Anywhere	Spalled	Repair spall by PDRS if crack not Removed	
Uncontrolled Crack	Longitudinal	Relatively parallel & within 1 ft. of joint; May cross or end at longitudinal joint	Full-depth	Saw and seal the crack; Epoxy uncracked joint	Cross-stitch' Crack

Defect Type	Defect Direction	Defect Location	Description	Repair Procedure	Alternate Procedure
Uncontrolled Crack	Longitudinal	Relatively parallel & in wheel path 1-4.5 ft -1.35 m from joint)	Full-depth, Hairline or Spalled	Remove and replace slab	Cross-stitch' Crack
Uncontrolled Crack	Longitudinal	Relatively parallel and further than 4.5 ft. from a long. joint or edge	Full-depth	Cross-stitch' crack; Seal longitudinal joint	
Saw cut or Uncontrolled Crack	Longitudinal	Anywhere	Spalled	Repair spall by PDRS if crack not Removed	
Uncontrolled Crack	Diagonal	Anywhere	Full-depth	FDR4	
Uncontrolled Crack	Multiple per Slab	Anywhere	Two cracks Dividing slab into 3 or more pieces	Remove and replace slab	

1 m=3.28 ft

HMWM = High molecular weight methacrylate poured over surface and sprinkled with sand for skid resistance.

LTR = load-transfer restoration; 3 dowel bars per wheel path grouted into slots sawed across the crack; Slots must be parallel to each other and the longitudinal joint.

FDR = full-depth repair; 10 ft long by one lane wide. Extend to nearest transverse contraction joint if 10 ft repair would leave a segment of pavement less than 10 ft long.

PDR = partial-depth repair; Saw around spall leaving 2 in. between spall and 2 in. deep perimeter saw. Chip concrete free, then clean and apply bonding agent to patch area. Place a separating medium along any abutting joint or crack. Fill area with patching mixture.

Cross-stitching; for longitudinal cracks only, drill $\frac{3}{4}$ " holes at 35° angle, alternating from each side of joint on 30-36 in. spacing. Epoxy #5 epoxy coated deformed steel tiebars into hole.

END OF SECTION 32 13 13

SECTION 32 13 13.10**PORTLAND CEMENT CONCRETE PAVEMENT - ML****PART 1 - GENERAL**

1. This section governs all the work and materials necessary for the construction of the Main Line Portland Cement Concrete Pavements.
2. All the requirements of the Kansas City Metropolitan Chapter of the American Public Works Association (APWA), *Standard Specifications and Design Criteria* apply as amended and supplemented by the Department of Public Works of the City of Kansas City, Missouri (KCMO). Sections of said Specifications will be hereinafter referred to as "APWA-KCMO."

PART 2 – PRODUCTS

1. Refer to Section 32 13 13 for the products and materials for this Work.

PART 3 – EXECUTION

1. Refer to Section 32 13 13 for the execution of this Work.

PART 4 - MEASUREMENT

4.1 Measurement

- A. The quantities of accepted work will be measured in the following units. All measurements will be plan measure except for authorized changes.
 1. PCC Pavement CY (Cubic Yard)

PART 5 - PAYMENT

5.1 Payment

Payment will be made at the respective unit or lump-sum price listed in the proposal and shall be full compensation for all labor, materials, and equipment necessary to complete the respective unit in place. There will be no separate measurement or payment for any item of work not specifically identified and listed in the proposal, and all such work shall be considered a subsidiary item with all costs pertaining thereto included in the prices for other items listed in the proposal. At the Engineer's option, partial payment may be made for any lump sum item listed in the proposal, providing that the Contractor is diligently and satisfactorily pursuing full completion of such partially complete item in accordance with the approved job progress schedule.

END OF SECTION

SECTION 32 14 13**PRECAST UNIT PAVING****PART 1 - GENERAL****1.1. RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2. SUMMARY

- A. Section Includes:
 - 1. Concrete pavers set in aggregate setting beds.
 - 2. Cast-in-place concrete edge restraints.
- B. Related Sections:
 - 1. Section 32 13 13 "Concrete Paving" for cast-in-place concrete curbs and gutters serving as edge restraints for unit pavers.

1.3. ACTION SUBMITTALS

- A. Product Data: For the following:
 - 1. Pavers.
- B. LEED Submittals:
 - 1. Product Data for Credit MR 4.1 and Credit MR 4.2: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
 - a. Include statement indicating costs for each product having recycled content.
 - 2. Product Data for Credits MR 5.1 and 5.2 - Local/Regional Materials:
 - a. Indicate location of manufacturing facility, including name, address, and distance between manufacturing facility and the project site. Provide manufacturer's documentation indicating location where the base materials were extracted, mined, quarried, harvested, etc. and the distance between this location and the project site. Also include material costs, excluding cost of installation.
- C. Sieve Analyses: For aggregate setting-bed materials, according to ASTM C 136.
- D. Samples for Verification:
 - 1. Full-size units of each type of unit paver indicated.

1.4. QUALITY ASSURANCE

- A. Source Limitations: Obtain each type of unit paver, joint material, and setting material from single source with resources to provide materials and products of consistent quality in appearance and physical properties.

- B. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
 - 1. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
- C. Preinstallation Conference: Conduct conference at Project site.

1.5. DELIVERY, STORAGE, AND HANDLING

- A. Store pavers on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied.
- B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.
- C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

1.6. PROJECT CONDITIONS

- A. Cold-Weather Protection: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen subgrade or setting beds. Remove and replace unit paver work damaged by frost or freezing.

PART 2 - PRODUCTS

2.1. CONCRETE PAVERS

- A. Regional Materials: Provide concrete pavers that have been manufactured within 500 miles (800 km) of Project site from aggregates that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles (800 km) of Project site.
- B. Concrete Pavers: Solid interlocking paving units complying with ASTM C 936 and resistant to freezing and thawing when tested according to ASTM C 67, made from normal-weight aggregates.
 - 1. Product: Subject to compliance with requirements, provide Pavestone Company "Verona" paver.
 - a. Field Paver
 - i. Thickness: 3-1/8 inches (80 mm) minimum.
 - ii. Face Size and Shape: 3" x 18" nominal, rectangular.
 - iii. Color: Pewter Blend (70% Pewter, 20% Limestone, 10% Charcoal).
 - b. Accent Paver 1
 - i. Thickness: 3-1/8 inches (80 mm) minimum.
 - ii. Face Size and Shape: 3" x 18" nominal, rectangular.
 - iii. Color: Limestone.
 - c. Accent Paver 2
 - i. Thickness: 3-1/8 inches (80 mm) minimum.
 - ii. Face Size and Shape: 3" x 18" nominal, rectangular.

iii Color: Charcoal.

2.2. CURBS AND EDGE RESTRAINTS

- A. Job-Built Concrete Edge Restraints: Comply with requirements in Section 03 30 00 "Cast-in-Place Concrete" for normal-weight, air-entrained, ready-mixed concrete with minimum 28-day compressive strength of 3000 psi (20 MPa).

2.3. AGGREGATE SETTING-BED MATERIALS

- A. Graded Aggregate for Subbase: Sound, crushed stone or gravel complying with ASTM D 448 for Size No. 57.
- B. Sand for Leveling Course: Sound, sharp, washed, natural sand or crushed stone complying with gradation requirements in ASTM C 33 for fine aggregate.
- C. Sand for Joints: Fine, sharp, washed, natural sand or crushed stone with 100 percent passing No. 16 sieve and no more than 10 percent passing No. 200 sieve.
1. Provide sand of color needed to produce required joint color.
- D. Separation Geotextile: Woven geotextile fabric, manufactured for separation, filtration, separation, and confinement applications; made from polyolefins or polyesters, with elongation less than 50 percent; complying with the following, measured per test methods referenced:
1. Apparent Opening Size: No. 30 sieve, maximum; ASTM D 4751.
 2. Permittivity: 0.50 per second, minimum; ASTM D 4491.
 3. UV Stability: 50 percent after 500 hours' exposure, ASTM D 4355.
 4. Product: Subject to compliance with the requirements provide TenCate Geosynthetics; Mirafi HP370 or comparable product by another manufacturer.
- E. Herbicide: Commercial chemical for weed control, registered with the EPA. Provide in granular, liquid, or wettable powder form.

PART 3 - EXECUTION

3.1. INSTALLATION, GENERAL

- A. Do not use unit pavers with chips, cracks, voids, discolorations, or other defects that might be visible or cause staining in finished work.
- B. Mix pavers from several pallets or cubes, as they are placed, to produce uniform blend of colors and textures.
- C. Cut unit pavers with motor-driven masonry saw equipment to provide clean, sharp, unchipped edges. Cut units to provide pattern indicated and to fit adjoining work neatly. Use full units without cutting where possible. Hammer cutting is not acceptable.
1. For concrete pavers, a block splitter may be used.
- D. Joint Pattern: Running bond, as indicated on Drawings.
- E. Tolerances: Do not exceed 1/16-inch (1.6-mm) unit-to-unit offset from flush (lippage) nor 1/8 inch in 24 inches (3 mm in 600 mm) and 1/4 inch in 10 feet (6 mm in 3 m) from level, or indicated slope, for finished surface of paving.
- F. Provide edge restraints as indicated. Install edge restraints before placing unit pavers.

1. Install job-built concrete edge restraints to comply with requirements in Section 03 30 00 "Cast-in-Place Concrete."

3.2. AGGREGATE SETTING-BED APPLICATIONS

- A. Compact soil subgrade uniformly to at least 95 percent of ASTM D 698/ASTM D 1557 laboratory density.
- B. Place separation geotextile over prepared subgrade, overlapping ends and edges at least 12 inches (300 mm).
- C. Place aggregate subbase and base, compact by tamping with plate vibrator, and screed to depth indicated.
- D. Place drainage geotextile over compacted base course, overlapping ends and edges at least 12 inches (300 mm).
- E. Place leveling course and screed to a thickness of 1 to 1-1/2 inches (25 to 38 mm), taking care that moisture content remains constant and density is loose and uniform until pavers are set and compacted.
- F. Treat leveling course with herbicide to inhibit growth of grass and weeds.
- G. Set pavers with a minimum joint width of 1/16 inch (1.5 mm) and a maximum of 1/8 inch (3 mm), being careful not to disturb leveling base. If pavers have spacer bars, place pavers hand tight against spacer bars. Use string lines to keep straight lines. Fill gaps between units that exceed 3/8 inch (10 mm) with pieces cut to fit from full-size unit pavers.
 1. When installation is performed with mechanical equipment, use only unit pavers with spacer bars on sides of each unit.
- H. Vibrate pavers into leveling course with a low-amplitude plate vibrator capable of a 3500- to 5000-lbf (16- to 22-kN) compaction force at 80 to 90 Hz. Use vibrator with neoprene mat on face of plate or other means as needed to prevent cracking and chipping of pavers. Perform at least three passes across paving with vibrator.
 1. Compact pavers when there is sufficient surface to accommodate operation of vibrator, leaving at least 36 inches (900 mm) of uncompacted pavers adjacent to temporary edges.
 2. Before ending each day's work, compact installed concrete pavers except for 36-inch (900 mm) width of uncompacted pavers adjacent to temporary edges (laying faces).
 3. As work progresses to perimeter of installation, compact installed pavers that are adjacent to permanent edges unless they are within 36 inches (90 mm) of laying face.
 4. Before ending each day's work and when rain interrupts work, cover pavers that have not been compacted and cover leveling course on which pavers have not been placed with nonstaining plastic sheets to protect them from rain.
- I. Spread dry sand and fill joints immediately after vibrating pavers into leveling course. Vibrate pavers and add sand until joints are completely filled, then remove excess sand. Leave a slight surplus of sand on the surface for joint filling.
- J. Do not allow traffic on installed pavers until sand has been vibrated into joints.
- K. Repeat joint-filling process 30 days later.

3.3. REPAIRING, POINTING, AND CLEANING

- A. Remove and replace unit pavers that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Provide new units to match adjoining units and install in same manner as original units, with same joint treatment and with no evidence of replacement.
- B. Pointing: During tooling of joints, enlarge voids or holes and completely fill with grout. Point joints at sealant joints to provide a neat, uniform appearance, properly prepared for sealant application.
- C. Cleaning: Remove excess grout from exposed paver surfaces; wash and scrub clean.

END OF SECTION

SECTION 32 14 43**POROUS PRECAST CONCRETE UNIT PAVING AGGREGATE BED SET****PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Solid concrete pavers with openings between pavers filled with aggregate.
 - 2. Recycled aggregate setting bed for pavers.
- B. Related Requirements:
 - 1. Division 31 Section "Earth Moving" for excavation and compacted subgrade.
 - 2. Division 32 Section "Concrete Paving" for cast-in-place concrete curbs that serve as edge restraints for porous paving.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

- A. Product Data: For the following:
 - 1. Pavers.
 - 2. Geotextiles.
- B. LEED Submittals:
 - 1. Product Data for Credit MR 4.1 and Credit MR 4.2: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
 - a. Include statement indicating costs for each product in the paver road section having recycled content.
 - 2. Product Certificates for Credit MR 5.1 and Credit MR 5.2: For products and materials required to comply with requirements for regional materials indicating location and distance from Project of material manufacturer and point of extraction or recovery for each raw material.
 - a. Include statement indicating cost for each regional material and the fraction by weight that is considered regional.
- C. Sieve Analyses: For aggregate materials, according to ASTM C 136.
- D. Samples:
 - 1. Full-size units of each type of unit paver indicated.

2. Aggregate fill.
3. Aggregate setting bed materials.

1.5 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for unit pavers, indicating compliance with requirements.
 1. For solid interlocking paving units, include test data for freezing and thawing according to ASTM C 67.

1.6 QUALITY ASSURANCE

- A. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
 1. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store pavers on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied.
- B. Store aggregates where grading and other required characteristics can be maintained and contamination can be avoided.

PART 2 - PRODUCTS

2.1 CONCRETE UNIT PAVERS

- A. Regional Materials: Pavers shall be manufactured within 500 miles of Project site from aggregates and cement that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles of Project site.
- B. Source Limitations: Obtain each type of paver from single source that has resources to provide materials and products of consistent quality in appearance and physical properties.
- C. Solid Concrete Pavers for Porous Paving: Solid interlocking paving units of shapes that provide openings between units, complying with ASTM C 936, resistant to freezing and thawing when tested according to ASTM C 67, and made from normal-weight aggregates.
 1. Product: Subject to compliance with requirements, provide Pavestone "Eco-Priora" paver.
 - a. Field Paver
 - i Thickness: 3-1/8 inches (80 mm).
 - ii Face Size and Shape: 4-3/4" x 9-1/2", rectangular.
 - iii Color: Limestone.
 - iv Finish: Platinum.
 - b. Accent Paver

- i Thickness: 3-1/8 inches (80 mm).
- ii Face Size and Shape: 4-3/4" x 9-1/2", rectangular.
- iii Color: Charcoal.
- iv Finish: Platinum.

2.2 AGGREGATE MATERIALS

- A. Regional Materials: Provide aggregate material that has been extracted or recovered, as well as manufactured, within 500 miles of Project site.
- B. Recycled, Graded Aggregate for Bedding Course and Void Filler: The bedding course and void filler aggregate shall be free of organics and soluble salts, or other contaminants likely to cause efflorescence. The grading requirement shall be in compliance with the following gradation chart. This material will be crusher run and washed.

ASTM Sieve Size	Percent Passing (by weight)
1/2 inch	100%
3/8 inch	94%-100%
1/4 inch	39%-94%
No. 4	23%-39%
No. 8	8%-23%
No. 16	0%-8%

- C. Recycled, Graded Aggregate for Base Course: The base course aggregate shall consist of open-graded stone and meet the following gradation chart. This material will be crusher run and washed.

ASTM Sieve Size	Percent Passing (by weight)
1-1/2 inch	100%
1 inch	90%-100%
3/4 inch	48%-90%
1/2 inch	27%-48%
1/4 inch	12%-27%
No. 4	0%-12%

- D. Recycled, Graded Aggregate for Sub-Base Course: The sub-base course aggregate shall consist of open-graded stone and meet the following gradation chart. This material will be crusher run.

ASTM Sieve Size	Percent Passing (by weight)
4 inch	100%
3 inch	80%-100%
2-1/2 inch	50%-80%
2 inch	20%-50%
1-1/2 inch	5%-20%
1 inch	0%-5%

2.3 CURBS AND EDGE RESTRAINTS

- A. Job-Built Concrete Edge Restraints: Comply with requirements in Section 03 30 00 "Cast-in-Place Concrete" for normal-weight, air-entrained, ready-mixed concrete with minimum 28-day compressive strength of 3000 psi (20 MPa).

PART 3 - EXECUTION

3.1 PREPARATION

- A. Proof-roll prepared subgrade according to requirements in Division 31 Section "Earth Moving" to identify soft pockets and areas of excess yielding. Proceed with porous paver installation only after deficient subgrades have been corrected and are ready to receive subbase and base course for porous paving.
- B. Site grades can be raised to the design subgrade elevation using clean native earth fill (free of deleterious material). This fill should be placed in lifts not exceeding six inches (6") and compacted to a minimum of ninety-five percent (95%) Standard Proctor density. The final subgrade profile should be uniformly compacted to a minimum of ninety-eight percent (98%) Standard Proctor density and proof-rolled to delineate soft areas. Removing the unstable soil and replacing with clean, dry compacted earth fill shall be performed to repair these areas.

3.2 INSTALLATION, GENERAL

- A. Do not use unit pavers with chips, cracks, voids, discolorations, and other defects that might be structurally unsound or visible in finished work.
- B. Mix pavers from several pallets or cubes, as they are placed, to produce uniform blend of colors and textures.
- C. Cut unit pavers with motor-driven masonry saw equipment to provide clean, sharp, unchipped edges. Cut units to provide pattern indicated and to fit adjoining work neatly. Use full units without cutting where possible. Hammer cutting is not acceptable.
- D. Tolerances:
 - 1. Variation in Plane between Adjacent Units (Lipping): Do not exceed 1/16-inch unit-to-unit offset from flush.
 - 2. Variation from Level or Indicated Slope: Do not exceed 1/8 inch in 24 inches and 1/4 inch in 10 feet or a maximum of 1/2 inch.

3.3 SUB-BASE, BASE, AND BEDDING COURSE INSTALLATION

- A. Compact soil subgrade uniformly to at least 95 percent of ASTM D 698 laboratory density.
- B. Proof-roll prepared subgrade to identify soft pockets and areas of excess yielding. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Architect, and replace with compacted backfill or fill as directed.
- C. The thickness of the sub-base course layer will depend upon the subgrade soil conditions and the anticipated traffic loadings. Final determination of sub-base course depth by Geotechnical Engineer, and as follows:
 - 1. The sub-base course shall consist of a minimum thickness of twelve inches (12") and be compacted using a vibratory 10-15 ton smooth-drum roller. It shall be installed in lifts not to exceed twelve inches (12"). Upon completion of the subbase course installation, the area shall be proof-rolled using a heavy rubber-

tired vehicle (such as a loaded tandem truck) to identify any areas requiring additional compaction. The sub-base course shall be installed to the elevation and cross-section per the plan documents.

- D. The base course shall consist of a thickness of 2"-3", (not to exceed 4"), placed in one lift, and be compacted using a vibratory 10-15 ton smooth-drum roller. The base course shall be installed to the elevation and cross-section per the plan documents (+/- 1/2").
- E. The bedding course shall be spread loose in a uniform layer to provide a depth after compaction of the paving units of 1"-2". The contractor shall screed the bedding course using either an approved mechanical screed apparatus or by the use of screed guides and boards.
 - 1. The screeded bedding aggregate shall not be subjected to any traffic by either mechanical equipment or pedestrian use prior to the installation of the paver units. The voids left after the removal of the screed rails shall be filled with loose aggregate as the paver bedding course proceeds.

3.4 PAVER INSTALLATION

- A. All edge restraints shall be constructed as shown on the plans and in place prior to the installation of the pavers and base course.
- B. The pavers shall be installed in approximately the order in which they were manufactured. No cluster shall be installed next to a cluster that was manufactured more than 1,000 cycles before or after.
- C. Lay pavers in the pattern as shown on the drawings. Lay pavers away from the existing laying face or edge restraint in such a manner as to ensure that the pattern remains square. Chalk lines shall be used upon the bedding course to maintain straight joint lines. Joint spacing between pavers shall be between 1/8" and 1/4"; however, the joint width may need to be increased to 3/8" (if necessary) to maintain straight joint lines. Lines and grades shown on the plans shall be established and maintained during the installation of the ecological permeable pavers.
- D. Pavers shall be cut using a masonry saw. Block splitting shall not be permitted. All cut faces shall be vertical. Dry cutting of the pavers shall be performed utilizing a dust collection system. If wet cutting method used, paver surface must be washed while still wet to remove cement dust and slurry.
- E. Once the pavers have been placed upon the bedding course and all cut pavers have been inserted to provide a full and complete surface, inspect the pavers for damaged units and remove and replace those units. Once all pattern lines have been straightened, initially compact the pavers and then place void filler into the paver openings to the top of the chamfer on the pavers and the surface swept broom clean.
- F. The pavement surface shall be compacted to achieve consolidation of the bedding course and paving stones and brought to design levels and profiles by two passes of a suitable plate compactor. Compaction of the pavers shall be accomplished by the use of a vibratory plate compactor capable of a minimum of 5,000 pounds of compaction force. No compaction shall be permitted within five feet (5') of unrestrained edges of the pavement.
- G. On completion of vibration after void filling, after compaction, inspect the pavers for damaged units and remove and replace those units. The surface tolerances shall be plus or minus 1/2" from finish levels and the pavers shall be flush to 1/4" above edge restraints.

- H. Additional void filler material shall be swept in the paver voids to within 1/2" from the bottom of the chamfer on the paving stones. Upon completion, the wearing course surface shall be swept clean of all excess materials. Remove from the site all surplus materials, equipment and debris resulting from these operations.

3.5 CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

- A. Comply with Waste Management Plan required under Division 01 Section "Construction Waste Management And Disposal."

END OF SECTION

SECTION 32 15 43
STONE SURFACING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes stone surfacing materials including the following:
1. Stone boulders.
 2. Stone mulch.
- B. Related Sections:
1. Division 31 Sections for site clearing and earth moving.

1.3 SUBMITTALS

- A. LEED Submittals:
1. Product Certificates for Credit MR 5.1 and Credit MR 5.2: For products and materials required to comply with requirements for regional materials indicating location and distance from Project of material manufacturer and point of extraction or recovery for each raw material.
 - a. Include statement indicating cost for each regional material and the fraction by weight that is considered regional.
- B. Samples:
1. Submit 4 by 6 inch color photographs of specified stone material with ruler or yardstick adjacent to stone for scale.

1.4 QUALITY ASSURANCE

- A. Off-site material should comply with LEED 5.1 and 5.2 credit for regional material. Consult with project landscape architect prior to obtaining off-site fill material.
- B. Landscape Architect or representative will field select and tag stone for stone boulders.
- C. Landscape Architect or representative will field locate position of stone boulders on site and approve installation.
- D. Preinstallation Conference: Conduct conference at Project site to comply with requirements of Division 01 Section "Project Management And Coordination."

1.5 DELIVERY, STORAGE AND HANDLING

- A. Store stone materials where grading and other required characteristics can be maintained and contamination avoided.

PART 2 - PRODUCTS**2.1 NATIVE STONE AND BOULDER**

- A. Regional Materials: Provide stone aggregates and boulders that have been extracted or recovered, as well as manufactured, within 500 miles of Project site.
- B. Stone Boulders:
1. Type: Local angular stone.
 2. Color Range: Tan/Buff/Limestone.
 3. Size: Landscape boulders type and quantity shall be determined by size and shape as follows:

Percent Of Total Quantity	Approximate Size Range		
	Length	Width	Height
30 - Large	6 feet	4 feet	3 to 4 feet
50 - Medium	4 feet	2 feet	1 to 3 feet
20 - Small	2 feet	1 foot	6 inches to 1.5 feet

- C. Stone Mulch:
1. Type: Local angular stone.
 2. Color Range: Tan/Buff/Limestone.
 3. Size: 3/4" to 1-1/2".

2.2 WEED-CONTROL BARRIERS

- A. Nonwoven Geotextile Filter Fabric: Polypropylene or polyester fabric, 3 oz./sq. yd. (101g/sq. m) minimum, composed of fibers formed into a stable network so that fibers retain their relative position. Fabric shall be inert to biological degradation and resist naturally encountered chemicals, alkalis, and acids.

PART 3 - EXECUTION**3.1 EXCAVATION**

- A. Excavate for placement of stone surfacing in planting areas to the limits indicated on the Drawings. Remove all soft, yielding material. Replace with suitable on-site material to subgrade. Compact to smooth, firm surface. Notify Landscape Architect for placement direction. Backfill and compact after placement.

3.2 STONE PLACEMENT

- A. Protect exposed faces of stone surfacing from scraping, gouging and similar damage during handling and placement.
- B. Protect stone faces from damage by pry-bars or mechanical placement equipment.
- C. Stone Boulders: Place in planting beds and swales where indicated on Drawings. Set stone with bottom 1/3 of depth in ground. See Drawing details.
- D. Stone Mulch: Install weed-control barriers before mulching according to manufacturer's written instructions. Completely cover area to be mulched, overlapping edges a minimum of 6 inches (150 mm) and secure seams with galvanized pins. Apply 3-inch (75-mm) average thickness of stone mulch and finish level with adjacent finish grades, where indicated on Drawings.

3.3 CLEANING

- A. Wash and clean stone boulder material prior to installation. Dry brush and clean boulders after installation.

3.4 CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

- A. Comply with Waste Management Plan required under Division 01 Section "Construction Waste Management And Disposal."

END OF SECTION

SECTION 32 16 13**CURBING****PART 1 - GENERAL****1.01 SCOPE OF WORK**

- A. Furnish the necessary equipment, labor and materials required and perform all work in connection with the construction of curbs and gutters as shown on the Drawings and as specified in American Public Works Association Standard Specifications and Design Criteria Section 2200 as revised, adopted, and provided by the director of Kansas City, Missouri Public Works current at the time of bidding and American Public Works Association Standard Specifications and Design Criteria Standard Drawing Number C-1 as revised, adopted, and provided by the Director of Kansas City, Missouri Public Works current at the time of bidding.

1.02 REFERENCE STANDARDS

- A. In addition to complying with all pertinent codes and regulations, comply with the referenced or applicable portions of the American Public Works Association Standard Specifications and Design Criteria as revised, adopted, and provided by the Director of Kansas City, Missouri Public Works current at the time of bidding.
 1. The following standards are referenced directly in this section. The latest version of these standards shall be used.
 - a. MCIB: Standard Concrete Specifications

PART 2 - PRODUCTS**2.01 MATERIALS**

- A. All Materials shall conform to Section 32 13 13 entitled "Portland Cement Concrete Pavement".

PART 3 - EXECUTION**3.01 CONSTRUCTION**

- A. The curbing shall be constructed or reconstructed to the configuration and to the lines and grades shown on the plans. Generally the curbing shall be placed prior to the placement of pavement or sidewalk sections, except when curb and gutter is integral with the pavement.
- B. Removal of Existing Curbing for Reconstruction

1. Existing curbing shall be totally removed to the nearest contraction or expansion joint or with the approval of the Engineer it may be sawed provided no free section is left that is less than 5 lineal feet in length, and provided the entire curbing section is sawed a minimum of 2 inches below any exposed surface, or sufficiently to prevent disturbance or damage to all adjacent structures or slabs, whichever is greater.

C. Grading and Subgrade Preparation

1. All excavation or embankment shall conform to Sections 31 22 00 and 31 23 13 entitled "Site Preparation and Grading" and "Subgrade Preparation" and as follows:
2. Compaction shall conform to Section 31 23 13.
3. The top 6 inches of the subgrade shall be compacted to obtain a density of 95% of the maximum standard proctor density within -2 to +2% of the optimum moisture content.
4. If during reconstruction operations, additional fill material is needed beneath the curb, it shall be base course material conforming to Section 32 11 00.

D. Forms

1. All forms shall be in good condition, clean, and free from imperfections. Each form shall not vary more than 1/4 inch in horizontal and vertical alignment for each 10 feet in length.
 - a. General
 - i. Face forms will be used with all curb standards except CG-2 (rollback) as applicable.
 - b. Forms shall have a height equal to or greater than the height of the curb face being formed.
 - c. The forms shall be set true to line and grade and shall be supported to stay in position while depositing and consolidating the concrete. The forms shall be designed to permit their removal without damage to the concrete. The forms shall be lubricated.

D. Curb Machine

1. A slip-form curb machine may be used in lieu of forms. The machine must be equipped with mechanical internal vibrators and be capable of placing curb to the correct cross section, line and grade within the allowable tolerances.

3.02 JOINTS

A. The joints shall be formed at right angles to the alignment of the curbing and to the depths specified by the appropriate standard drawing or as shown on the plans.

B. Isolation Joints

1. Isolation joints shall be placed at all radius points, driveways, curb inlets, or where directed by the plans or Engineer.

a. Material

i. Isolation joints shall be formed by a one piece, 3/4 inch thick preformed joint filler cut to the configuration of the correct curb section, and conforming to Section 32 13 13.

b. Stability

i. Isolation joints shall be secured in a manner so they will not be disturbed by depositing and consolidating of concrete.

c. Edging

i. The edges of the joints shall be rounded with an edging tool of 1/4 inch radius.

C. Contraction Joints

1. Curbing shall have contraction joints installed at intervals of not less than 10 feet or more than 15 feet. They shall extend through the entire curb section from the top of the curb to a depth 2 inches below pavement surface.

2. Method

a. Contraction joints shall be sawed.

i. When sawing joints, the contractor shall begin as soon as the concrete hardens sufficiently to prevent excessive raveling along the saw cut and shall finish before conditions induce uncontrolled cracks, regardless of the time or weather. When joint sealing backup material is specified with sawed joints, the first stage, which provides a relief cut shall be approximately 1/8 inch wide, and shall be to plan depth. The second stage which widens the joints to allow the insertion of joint sealing backup material to plan depth shall not be performed until the concrete is at least 48 hours old, and shall be delayed longer when the sawing causes raveling of the concrete. If second stage sawing is performed prior to the completion of the curing period, the contractor

shall maintain the cure by use of curing tapes, plastic devices, or other materials approved by the engineer.

- ii. Saw joints shall be a minimum of 2 inches deep.

D. Joint Sealer

1. When specified, joint sealants shall conform to Section 32 13 13.

3.03 CONCRETE WORK

A. Concrete for curbing shall be placed in accordance with the requirements of Section 32 13 13. Isolation and contraction joints shall be constructed as shown on the plans, standard drawings, or where directed by the Engineer.

B. Concrete Placement

1. Concrete Placement: Concrete shall be mechanically vibrated except for mixes No. WA-610-1-4-0.410 and WA-634-3/4-4-0.410 and shall not be allowed to extrude below the forms to cause an irregular alignment of the abutting street pavement.

C. Finishing

1. After placing and initial strike-off the curb shall be tooled to the required radii. If the surface of the concrete is sufficiently wet that a ridge is formed at the inside of the radius tool, finishing will cease until the excessive moisture has evaporated.
2. After initial set, the face forms shall be removed and the surface finished to the required dimensions. No water, dryer, or additional mortar shall be applied to the free surface of the concrete.
3. The finished surface of the concrete shall be broomed perpendicular to the curb with a clean broom to provide an antiskid surface.
4. In all cases the finished curb shall have a true surface, free from sags, twists, or warps, and shall have a uniform color and appearance.

D. Curing

1. As soon as practical after the concrete is finished it shall be cured with a liquid curing membrane meeting the requirements of Section 32 13 13, applied according to the manufacturer's directions.
2. If front and/or back forms are removed from finished curbing within a period of 72 hours of placement these surfaces shall also be cured.
3. Wet burlap, cotton mat, waterproof paper, polyethylene sheeting or earth backfill is not an acceptable curing method for curbing.

E. Protection

1. The Contractor shall protect the concrete work against damage or defacement of any kind until it has been accepted by the Engineer. Concrete which is damaged or defaced, shall be removed and replaced, or repaired to the satisfaction of the Engineer, at the expense of the Contractor.

F. Temperature Limitations

1. Concrete work shall be placed in accordance with requirements of MCIB.

G. Repairing Defects

1. Defects in the concrete shall be repaired in accordance with Section 32 13 13.

3.04 BACKFILL

- A. Backfill shall conform to embankment or backfill as specified in Section 31 22 00.
- B. The Contractor shall be responsible for the repair of any street pavement disturbed by the construction to the satisfaction of the Engineer.

3.5 JOINT SEALING AND CLEAN-UP

- A. Joint sealer shall be applied in accordance with the manufacturer's directions within 7 days of the placement of the concrete. The Contractor shall be responsible for the removal of excess dirt, rock, broken concrete, concrete splatters and overspray from the area of the construction.

3.6 SURFACE TOLERANCES

- A. Curbing shall have a surface tolerance of 1/4 inch in 10 feet when checked with a ten foot straightedge.

END OF SECTION 32 16 13

SECTION 32 16 23**STANDARD SIDEWALKS, SIDEWALK RAMPS, DRIVEWAYS, AND
BICYCLE/PEDESTRIAN PATHS**

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. Furnish the necessary equipment, labor and materials required and perform all work in connection with the construction or reconstruction of sidewalks, sidewalk ramps, driveways, and bicycle/pedestrian paths as shown on the Drawings and as specified at the time of bidding in American Public Works Association Standard Specifications and Design Criteria Section 2301 titled "Standard Sidewalks, Sidewalk Ramps, Driveways, and Bicycle & Pedestrian Paths" as revised, adopted, and provided by the Director of Kansas City, Missouri Public Works.

1.02 REFERENCE STANDARDS

- A. In addition to complying with all pertinent codes and regulations, comply with the referenced or applicable portions of the American Public Works Association Standard Specifications and Design Criteria available at the time of bidding.
- B. The following standards are referenced directly in this section. The latest version of these standards shall be used.

ADAAG:

Section 4.7 – Curb Ramps

ASTM:

D 1751 Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)

D 1752 Standard Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction

D 2805 Standard Test Method for Hiding Power or Paints by Reflectometry

MCIB

Section 1 Concrete Materials

Section 2 Outdoor Concrete Exposed to Freezing and Thawing

Section 3 Concrete Mix Design Tables

PART 2 - PRODUCTS

2.01 MATERIALS

- A. All materials in this section shall conform to the requirements of Section 32 13 13 entitled "Portland Cement Concrete Pavement," under subsection 2.01 Materials unless otherwise noted.
- B. Concrete Mix: Concrete shall conform to APWA Section 2209.2 titled "Curbing Materials" and be MCIB WA610-1-4-0.410 or WA561-1-2-0.410.
- C. Contractor shall recognize the effects of temperature, wind, and humidity when placing and curing concrete. When the ambient air temperature is 90 degrees F (32 degrees C) or higher, a retarder shall be used in the concrete mix. When the ambient air temperature is 90 degrees F (32 degrees C) or higher and the wind velocity is above 20 mph, evaporation shall also be controlled.

PART 3 - EXECUTION

3.01 CONSTRUCTION DETAIL

- A. Construction Details
 - 1. The sidewalks, sidewalk ramps, driveways or bicycle/pedestrian paths shall be constructed or reconstructed to the configuration, and to the lines and grades shown by the plans. Generally sidewalks, sidewalk ramps, driveways, and bicycle/pedestrian paths should be constructed after the curbing. Sidewalk ramp construction shall comply fully with all requirements for sidewalks in this section and shall comply with the requirements of ADAAG Section 4.7.
 - 2. Ramp construction and layout shall conform to APWA Standard Drawing "Sidewalk Ramp Details" which is an interpretation of ADAAG Section 4.7.
 - 3. Removal: Existing sidewalks, sidewalk ramps, driveways, or bicycle/pedestrian paths shall be totally removed to the nearest contraction or isolation joint, unless otherwise specified by the Engineer. The section shall be sawed full depth.
 - 4. Grading and Subgrade Preparation: All excavation or embankment required in the grading or subgrade preparation shall be as defined in the Sections 31 22 00 and 31 23 13 entitled "Site Preparation and Grading" and "Subgrade Preparation," except as follows:
 - a. The top 6 inches (150 mm) of the subgrade shall be compacted to obtain a density of 95 percent of maximum in conformance with Section 31 23 13 entitled, "Subgrade Preparation," subsection 3.03 Construction.
 - b. On reconstruction projects or after roadway grading is completed on new construction, additional fill material needed beneath sidewalks or driveways shall be crushed stone

conforming to Section 32 11 00 entitled "Untreated Compacted Aggregate," placed and compacted in conformance with Section 32 11 00 subsection 3.01.

5. Forms: All forms shall be in good condition, clean, and free from imperfections. Each form shall not vary more than 1/4 inch (0.64 cm) in horizontal or vertical alignment for each 10 feet (3.05 m) in length.
 - a. Material and Size: Forms shall be made of metal unless otherwise approved by the Engineer and shall have a height equal to or greater than the depth of the sidewalk, driveway, or bicycle/pedestrian path section.
 - b. Strength: Forms shall be of such cross-section and strength, and so secured as to resist the pressure of the concrete when struck off, vibrated, and finished, and the impact and vibration of any equipment which they may support.
 - c. Installation: The forms shall be set true to line and grade, supported through their length and joined neatly in such a manner that the joints are free from movement in any direction.
 - d. Preparation: Forms shall be cleaned and lubricated prior to each use and shall be so designed to permit their removal without damage to the new concrete.
6. Slip-form Machine: A slip-form machine may be used in lieu of forms. The machine must be equipped with mechanical internal vibrators and be capable of placing concrete to the correct cross section, line and grade within the allowable tolerances.
7. Location. All public sidewalks within Kansas City shall be constructed of PC concrete and shall be located in the public right-of-way or within a public sidewalk easement. The standard location shall be one foot from the right-of-way or easement line. Sidewalks shall be constructed to allow access to all pedestrian signal actuation devices and bus stop shelters.
8. Required Dimensions. The minimum width of public sidewalks on residential streets shall be four feet. The minimum width of public sidewalks along higher class streets shall be five feet. The minimum width of public sidewalks abutting curb shall be five feet. Uninterrupted four foot wide walks shall have a five foot square passing space every 200 feet. All public sidewalks shall be a minimum of four inches thick.
9. Grades and Slopes. The grade or slope along the length of the walk shall be as near parallel to the street gradient as practical. The maximum longitudinal slope shall be 5%, except where a

variance from street grade has been approved by the City Engineer. The standard cross slope shall be 2% maximum toward the street and this 2% slope shall be carried thru driveways. The finish grade of the sidewalk shall allow the grass area between the curb and the sidewalk (sometimes called parkway) to slope toward the street at a maximum grade of 4%, except as shown on the plans.

10. Wheelchair accessible curb ramps shall be constructed at all street crossings and shall conform to the most current adopted KCMO Sidewalk Ramp Standard drawings. The minimum allowable thickness for wheelchair accessible curb ramps shall be eight inches. Curb ramps shall be poured monolithically with the curb.
 11. Maximum slope of ramps shall be one inch per foot. Minimum width shall be four feet, except along thoroughfare corridors where the width shall be five feet. Transitions from ramps to walks, gutters, or streets shall be flush and free of abrupt changes. Side (flare) slopes of ramps shall not exceed 1:10 where such side slopes are in the normal path of pedestrians on adjacent portions of sidewalk. Ramps with curbs may be used when pedestrians would not normally cross through the ramp. Surface texture shall be a coarse broom finish transverse to the slope of the ramp. If the street curb has not been constructed to receive the sidewalk ramp, the curb shall be removed and reconstructed as required.
- B. Joints: Unless directed by the Engineer the joints shall be formed at right angles to the alignment of the sidewalk, driveway, or bicycle/pedestrian path and to the configuration specified by the plans or standards.
1. Joint Patterns: All joints shall be constructed on straight and true lines.
 - a. Sidewalks: Sidewalk surfaces shall be marked with a transverse joint spaced at a distance equal to the width of the sidewalk. Sidewalks greater than 6 feet (21.8 m) in width shall be divided by longitudinal joints spaced not less than 30 inches (760 mm) nor more than 60 inches (1.5 m) with transverse joints spaced to form a square pattern. Edger tool marks shall remain showing unless the sidewalk is slip-formed and subsequently sawed. Curb joints should align with sidewalk joints where they abut.
 - b. Driveways and bicycle/pedestrian paths: In general, no driveway slab dimension shall exceed 10 feet (3.05 m), although widths no more than 24 times the slab thickness will be permitted to match existing joint patterns.
 2. Isolation joints. Isolation joints shall be placed as shown on the standard drawings, where new concrete abuts existing, against structures, and as directed by the Engineer or as indicated on the plans. In no case shall isolation joints exceed 250' center to center.

Isolation joints are often referred to as “expansion joints” in some documents and drawings.

- a. General: The preformed isolation joint material shall be left 1/2 inch (13 mm) below the surface, or a suitable tear strip will be provided to allow for the application of the joint sealer.
 - b. Material: Isolation joints shall be formed by a 1 piece; 1/2 inch (13 mm) thick non-extruding preformed joint filler cut to the configuration of the abutting section. The filler material shall be full depth, and shall conform to ASTM D1751, D1752 or D7174. D1752 or D7174 material shall be used against curved surfaces, around utility boxes or poles, or against other irregular surfaces, and may be used for all applications.
 - c. Stability: Isolation joints shall be secured in a manner so they will not be disturbed by depositing and consolidating the concrete.
 - d. Edging: The newly poured edges of these joints shall be rounded with an edging tool of 1/4inch (6 mm) radius.
3. Contraction joints: Contraction joints shall be 1 inch (25 mm) deep by 1/8 inch (3 mm) wide with 1/4 inch (6 mm) radii rounded edges.
- a. Edging: Edger marks shall remain showing unless the sidewalk, driveway or bicycle/pedestrian path is slip formed and subsequently sawed.
 - b. Slip forming: Contraction joints may be sawed 1/8 inch (3 mm) wide by 1/3rd the thickness of the slab.
 - c. Joint Sealer: joint sealer is not required.
- C. Concrete Work: Concrete work shall be placed in accordance with the requirements of MCIB.
1. Concrete Placement: Deposit and consolidate concrete as close to the final position as possible, beginning at one corner of the forms. Perform necessary hand spreading with shovels or come-alongs, not with rakes or vibrators. Do not walk in the fresh concrete with boots or shoes coated with earth or foreign substances. When concrete is placed on a sloped surface, begin concrete placement at the lowest area.
 2. Finishing:
 - a. Strike off the concrete with a vibratory screed or a hand strike-off method when adequate consolidation is attained. Immediately after strike-off, the concrete may be bullfloated to remove any high or low spots. Minimize the use of the bullfloat.

- b. Do not finish concrete with water standing on the surface or when edging tool makes a ridge on its inside edge. Resume finishing when excess moisture evaporates. All edges of the slab shall be finished with a ¼ inch (6mm) radius edger.
 - c. After finishing, the surface of the concrete shall be broomed with a fine clean broom to provide an antiskid surface, and the edges and joints retooled unless slipformed.
 - d. In all cases the finished sidewalk, driveway, or bicycle/pedestrian path shall have a true surface, free from sags, twists, or warps, and shall have a uniform color and appearance.
3. Curing: As soon as practical after the concrete is finished it shall be cured with an acceptable white pigmented liquid curing membrane applied according to manufacturers directions.
- a. If forms are removed within a period of 72 hours of placement those formed surfaces shall also be cured.
 - b. Wet burlap, cotton mats, waterproof paper, polyethylene sheeting or earth backfill shall not be acceptable as curing methods.
4. Protection: The Contractor shall protect the concrete work against damage or defacement of any kind until it has been accepted by the City. Concrete which is damaged or defaced shall be removed and replaced or repaired to the satisfaction of the Engineer, at the expense of the Contractor.
5. Temperature Limitations: Concrete shall be placed in accordance with the requirement of MCIB, as modified. Concrete with temperature above 90 degrees F may be placed provided sufficient labor and equipment is furnished to pour, finish and cure the concrete to meet city standards before it sets.
6. Repairing Defects: Defects in the concrete shall be repaired in accordance with Section 32 13 13 entitled "Portland Cement Concrete Pavement," subsection 3.07 Repairing Defects.
- D. Backfill: A minimum of 24 hours shall elapse before forms are removed and 5 days shall elapse or the concrete must have attained 75% of its 28 day compressive strength before pavement is backfilled unless otherwise approved by the Engineer. Backfill shall be accomplished in accordance with Sections 31 22 00 and 31 23 13 entitled "Site Preparation and Grading" and "Subgrade Preparation."
1. The Contractor shall be responsible for the repair of any street pavement disturbed by the construction.

- E. Joint Sealing and Clean-Up: All isolation joints shall be sealed with an approved one-component, moisture-curing, non-priming, gun-grade, elastomeric polyurethane joint sealant that meets the requirements of ASTM C920, Type S, Grade NS, Class 25, Use NT and M. It shall be applied in accordance with the manufacturer's instructions within 7 days of the placement of the concrete.
1. The Contractor shall be responsible for the removal of excess dirt, rock, broken concrete, splatters and overspray from the construction area within 10 days unless otherwise directed by the Engineer.
- F. Surface Tolerances: Sidewalks, driveways, or bicycle/pedestrian paths shall have a surface tolerance of 1/4 inch (6 mm) in 10 feet (3.05 m) when checked with a 10 foot (3.05m) straightedge. Vertical deflections at sidewalk joints shall not exceed ¼ inch (6 mm).
- G. Detectable Warnings: Detectable warnings are required standardized surface features built in or applied to walking surfaces on sidewalks or ramps to warn visually impaired people of hazards on a circulation path. Those hazards include, but are not limited to interfaces between sidewalks and areas where moving vehicles may be present.
1. Detectable warnings shall be installed whenever sidewalk curb ramps are constructed or altered.
 2. Dimensions: Detectable warnings shall consist of raised truncated domes with a 0.9 in (23 mm) nominal diameter, a nominal 0.2 in (5mm) height, and a nominal center to center spacing of 2.35 in (60 mm). They shall extend across the full walking surface of the walk or ramp, and shall be 2 feet (0.6 m) long in the direction of pedestrian travel.
 3. Contrast: Detectable warnings shall contrast visually with adjoining surfaces, either light-on-dark or dark-on-light. The material used to provide contrast should contrast by at least 40%. Contrast in percent is determined by:

$$\text{Contrast} = [(B1 - B2) / B1] \times 100$$

Where: B1=light reflectance value (LRV) of the lighter area
B2=light reflectance value (LRV) of the darker area

Light Reflectance Value shall be determined by ASTM D2805 for painted surfaces or by visual comparison to paint chips with LRVs determined by ASTM D2805 for non-painted surfaces. Note that in any application both white and black are never absolute: thus B1 is always less than 100, and B2 is always greater than 0.
 4. Material: The material used to provide contrast shall be an integral part of the walking surface.

5. Submittals shall include:
 - a. Manufacturer product data and application instructions
 - b. Samples to visually demonstrate color contrast
 - c. Details of product composition, tests performed, product service experience, limitations to coating, application procedures, and Material Safety Data Sheets (MSDS)
 - d. Manufacturers certification that the product(s) meets or exceeds these specifications

END OF SECTION 32 16 23

SECTION 32 16 23.10**SIDEWALKS, DRIVEWAYS, AND CURBS - ML****PART I - GENERAL****1.1 SUMMARY****A. Description**

The work in this Section consists of constructing concrete curbs, curb transitions, curb and gutter, pedestrian access ramps, sidewalks, driveways, concrete strips, detectable warning surface, as shown on the Contract Drawings and as specified herein.

1.2 REFERENCES

American Public Works Association Standard Specifications and Design Criteria Section 2301 titled "Standard Sidewalks, Sidewalk Ramps, Driveways, and Bicycle & Pedestrian Paths" as revised, adopted, and provided by the Director of Kansas City, Missouri Public Works.

1.3 REFERENCE STANDARDS**A. Refer to Sections 32 16 13 and 32 16 23 for the applicable reference standards****PART II - PRODUCTS****A. Refer to Sections 32 16 13 and 32 16 23 for the products and materials for the Work.****PART III - EXECUTION****A. Refer to Sections 32 16 13 and 32 16 23 for the execution of the Work.****PART IV - MEASUREMENT****4.1 Item Basis – Measurement of the following concrete installations will be per the unit of measurement of each item as listed below.**

Pay Item	Unit of Measurement
Type CS Curb	LF, Linear Feet
Type C-1 Curb	LF, Linear Feet
Type CG-1 Curb	LF, Linear Feet
Concrete Sidewalk	SY, Square Yard
Concrete Sidewalk Ramp	SY, Square Yard
Detectable Warning Strip	LF, Linear Feet
Type II Concrete Driveway	SY, Square Yard

PART V - PAYMENT**5.1 General – The accepted measured quantity of each pay item will be paid for at the Contract unit price per unit of measurement. The Contract unit price will be payment in full for furnishing all labor, materials, tools, equipment and incidentals, and doing all Work necessary to complete the Work specified.****END OF SECTION**

SECTION 32 17 23**PAVEMENT MARKINGS****PART I - GENERAL****1.1 SUMMARY****A. Description**

Methods and materials for installing pavement marking materials, including Preformed Polymer Pavement Marking Tape, Preformed Thermoplastic, Epoxy, Preformed Removable Lane Tape, and other pavement marking materials.

B. Related Sections

1. 01 55 26 – Traffic Control

1.2 REFERENCES

<u>Sponsor</u>	<u>Number</u>	<u>Subject</u>
MoDOT	620	Standard Plans for Highway Construction - Pavement Markings
MoDOT	620 & 1048	Missouri Standard Specifications Book for Highway Construction (2011), including General Provisions and Supplemental Specifications to the 2011 Missouri Standard Specifications for Highway Construction
ASTM	D 4592	Preformed Plastic Pavement Marking Tape for Limited Service Life
ASTM	D 913	Evaluating Degree of Resistance to Wear of Traffic Paint
ASTM	E 303	Measuring Surface Frictional Properties Using the British Pendulum Tester
FHWA	MUTCD	Manual on Uniform Traffic Control Devices

1.3 SUBMITTALS AND INFORMATION TO BE RETAINED

- A. Submittals shall be made in accordance with the requirements of the KCMO's CM/GC General Conditions, except as modified herein.
- B. Submit a separate Tape Manufacturer's Material Certification for each production lot that is shipped.
- C. Provide a Manufacturer Warranty Bond for the installed price of the material, or the following amount, whichever is greater:

-
1. Pavement Marking Tape: \$140,000.
 2. Preformed Thermoplastic: \$100,000.
- D. Provide a full Manufacturer Warranty covering 100 percent of the installed price of all materials, equipment, and labor.
1. Manufacturer is responsible for quality control of the materials, proper placement by the Contractor or Subcontractor, and all other factors that affect the service life of the materials.
 2. In the event of a performance failure, remove and/or replace 100 percent of the markings for all failed sections at no cost to KCMO.
 3. Failed sections for Pavement Marking Tape and Preformed Thermoplastic are defined in KCMO's General Conditions.
- 1.4 QUALITY ASSURANCE/QUALITY CONTROL
- Quality assurance/quality control shall be made in accordance with the requirements of the Project Quality Plan.
- 1.5 DELIVERY, STORAGE, AND HANDLING
- A. In accordance with manufacturer's recommendations.
 - B. Provide Material Safety Data Sheets (MSDS) upon delivery of material.
- 1.6 MANUFACTURER SERVICE REQUIREMENT
- Manufacturer shall provide technical support to the Contractor during the placement of the marking materials, including information about handling, storage, placement and other training that may preserve the quality of the installed markings.
- 1.7 SERVICE LIFE TESTING
- A. Contractor will perform service life testing.
 - B. Performance Measures:
 1. Retro-reflectivity
 2. Color contrast and stability
 3. Durability under all traffic volumes and wear conditions
 - C. Retro-reflectivity is measured using a Federally approved instrument (30 m geometry).

- D. When performing Service Life Testing, take readings on clean surface areas free of debris.

PART II – PRODUCTS

2.1 MATERIALS

- A. Preformed Polymer Pavement Marking Tape, Thermoplastic Pavement Marking Tape, Epoxy, Drop-on Glass Beads, Preformed Removable Pavement Marking Tape, and ancillary materials shall be as outlined in MoDOT Specification Section 1048.

2.2 PAVEMENT GRINDING EQUIPMENT

- A. Use machinery capable of grinding to required depth and cross-section, and with sufficient power and stability to maintain an accurate depth of cut for pavement marking material.
- B. Use appropriate cleaning equipment capable of picking up all millings during and after grinding operations.

2.3 PAVEMENT MARKING USE

- A. Preformed Polymer Tape shall be used for permanent applications of crosswalks, stop bars, pavement arrows and messages, regardless of pavement material. All Preformed Polymer Tape shall be ground in to the pavement in accordance with the specifications herein.
- B. Thermoplastic pavement marking material shall be used for permanent applications of longitudinal lane lines to be installed in bituminous material.
- C. Epoxy pavement marking material shall be used for permanent applications of lane lines to be installed in concrete material. All epoxy pavement markings shall be ground into the pavement in accordance with the manufacturer's specifications.
- D. All temporary pavement marking shall be consist of one of the following options, under conditions as described below.
 - 1. Preformed Removable Pavement Marking Tape, for temporary conditions to exist longer than three days.
 - 2. Acrylic Copolymer Fast Dry Pavement Marking Paint, for temporary conditions to exist three days or less.

PART III – EXECUTION

3.1 REMOVAL OF EXISTING PAVEMENT MARKINGS

- A. Pavement marking removal operations shall be as outlined in MoDOT Specification Section 620.70.
- B. Do not eliminate or obscure existing striping, in lieu of removal, by covering with black paint or any other covering.
 - 1. The Engineer may grant prior written approval for use of black paint or other obscuring material for work durations shorter than “long term stationary” as defined in the Temporary Traffic Control section of the MUTCD.
- C. Use equipment specifically designed for removal of pavement marking material.

3.2 REMOVAL OF TEMPORARY PAVEMENT MARKINGS

- A. All temporary pavement marking removal work shall be coordinated with the construction activities. Temporary pavement markings shall be removed in advance of the traffic shift unless otherwise approved by the Engineer. Temporary pavement markings shall be removed during the same day or days that the traffic shift is accomplished, just prior to the traffic shift.

3.3 GROOVING BITUMINOUS and/or CONCRETE PAVEMENT SURFACES FOR EPOXY and POLYMER PREFORMED PAVEMENT MARKINGS

- B. The pavement markings are to be grooved into the pavement surfaces. GRINDER-TYPE CUTTING HEADS CANNOT BE USED. The goal of the grooving process is to protect the pavement marking from snowplow damage and ultimately extend the service life of the pavement markings. Grooving operations are incidental to permanent pavement marking operations.

The Contractor has the option to dry or wet groove the pavement while the roadway is open or closed to traffic. The groove must be cleaned completely prior to pavement marking application, using an air compressor with at least 185 CFM air flow and 120 PSI air pressure. The compressor must be equipped with a moisture and oil trap, and cannot have more than 50 feet of 3/4 inch ID hose between the compressor and the air nozzle. The air nozzle must have an inside diameter of 1/2 inch or greater.

- C. The grooving shall be performed by a self-propelled machine equipped with gang stacked diamond cutting blades mounted on a floating head with controls capable of providing uniform depth and alignment.

The cutting heads shall consist of stacked 1/8 inch to 3/8 inch wide diamond tipped cutting blades. The spacers between each blade must be such that the raise in the bottom of the finished groove between the blades is less than 25% of the groove depth. The resulting bottom of the groove shall have a fine corduroy finish. If a coarse tooth pattern is present, the Contractor shall increase the number of blades and/or decrease the thickness of the spacers on the cutting head.

The equipment shall be capable of grooving the total width of the groove in one pass or be capable of grooving uniform depths with multiple passes. The maximum number of passes is detailed below. If multiple passes are used, the ridge between passes shall be mechanically removed prior to groove cleaning and pavement marking application.

The equipment shall be capable of grooving double lines simultaneously or parallel lines to a uniform depth with two passes.

The equipment shall be self-vacuuming and leave the cut groove ready for pavement marking installation. Dry cut grooving without a vacuum will only be allowed if markings run perpendicular to the roadway, such as Stop Bars. The pavement marking manufacturer shall approve the equipment and method used.

- D. The grooving shall be performed within the following tolerances. Failure to meet these tolerances will result in the suspension of work until the Contractor can demonstrate that these tolerances can be met to the satisfaction of the Engineer. The pavement marking system shall be applied so that it is centered within the groove.

GROOVE WIDTH AND MAXIMUM NUMBER OF PASSES		
MARKING WIDTH	GROOVE WIDTH	MAX NUMBER OF PASSES
4 inches	5" ± 1/8"	1
6 inches	7" ± 1/8"	1
8 inches	9" ± 1/8"	1
12 inches	13" ± 1/8"	2
24 inches	25" ± 1/8"	3

- E. Groove Depth
1. The groove depth for Epoxy pavement markings shall be 30 mil ± 10 mil.
 2. The groove depth for Preformed Polymer Tape pavement markings shall be 110 mil ± 10 mil.
 3. Thermoplastic pavement markings shall NOT be grooved.
- F. Since pavements are irregular, the depth of groove across the width may vary. To compensate for this, the depth of the groove shall be measured from the bottom of the groove to a straight edge extended over the groove from the pavement surface opposite the pavement joint.

FULL DEPTH GROOVE LENGTHS	
Full Depth Groove Length (Broken Line)	10 feet ± 3 inches
Tapers At End of Each Line	6 inches to 9 inches
Space Between Double lines	4 inches ± 1/4 inch

- G. The groove shall be placed 2 inches \pm 1 inch from the edge of joints or seams along edge or centerline, unless otherwise indicated in the Plan.

Grooving alignment deviations from the control guide or existing lines specified by the Engineer shall not exceed 2 inches.

All pavement markings to be grooved in shall be placed in accordance with pavement marking or element manufacturer's instructions. New bituminous pavement shall not be grooved within a minimum 10 days of the placement of the final course of pavement, unless otherwise directed by the Engineer.

If the ground-in Epoxy markings are to be installed in the same location where there are existing pavement markings, including interim or temporary, the removal of the existing pavement markings shall be incidental to and included within the Epoxy (GR IN) pay item. The Contractor may cut the groove and remove the existing marking in a simultaneous operation.

3.4 Application

- A. Conduct surface preparations in accordance with manufacturer's recommendations.
- B. Operate equipment in the direction of the normal flow of traffic.
- C. Apply Pavement Marking Materials according to manufacturer's specifications.

END OF SECTION

SECTION 32 17 23.10**TEMPORARY PAVEMENT MARKINGS****PART I - GENERAL****1.1 SUMMARY****A. Description**

1. This work includes the installation of temporary pavement markings and the removal of existing pavement markings as shown on the Contract Drawings and as specified herein. Generally, the work involves striping for detours, lane closures and arrows for restricted lane movements.
2. Temporary pavement markings shall conform to the requirements of Missouri Department of Transportation (MoDOT) Specifications, except as modified herein.

1.2 REFERENCES

<u>Sponsor</u>	<u>Number</u>	<u>Subject</u>
MODOT	01558	Temporary Pavement Markings
MODOT	02765	Pavement Marking Paint
ASTM	D 4592	Preformed Plastic Pavement Marking Tape for Limited Service Life
ASTM	D 4956	Retroreflective Sheeting for Traffic Control

1.3 SUBMITTALS

Submittals shall be made in accordance with the requirements of the Project Quality Plan, except as modified herein.

PART II - PRODUCTS**2.1 MATERIALS**

- A. Provide traffic paint conforming to the requirements of Missouri Department of Transportation (MODOT) Specifications Section 01558.
- B. Provide glass beads conforming to the requirements of Missouri Department of Transportation (MODOT) Specifications.
- C. Provide pavement marking tape conforming to the requirements of Missouri Department of Transportation (MODOT) Specifications.
- D. Provide temporary raised pavement markers conforming to the requirements of Missouri Department of Transportation (MODOT) Specifications.

PART III - EXECUTION**3.1 GENERAL**

- A. Stop bars shall be placed parallel to crosswalks, unless otherwise noted on plans.

- B. Stop bars shall be located a minimum of four feet behind the crosswalk.
- C. Place pavement markings for lane and center lines on all streets intersection the streetcar corridor 120' back from the stop bar or crosswalk.
- D. The broken line pavement marking pattern shall be a ten-foot stripe followed by a thirty-foot gap.
- E. The dotted line pavement marking patterns shall be as indicated on the plans.

3.2 TEMPORARY PAVEMENT MARKINGS

- A. Temporary pavement markings shall conform to the requirements of the Traffic Control Plan.
- B. All temporary pavement marking shall be by one of the following options:
 - 1. Highway traffic paint and glass beads.
 - 2. Reflectorized pavement marking tape.
 - 3. Raised temporary pavement markers.
- C. All temporary pavement marking work shall be coordinated with the construction activities. Temporary pavement markings shall be installed in advance of traffic use unless otherwise approved by the Engineer. Temporary pavement markings shall be installed during the same day or days that the traffic shift is accomplished, just prior to the traffic shift.

3.3 REMOVAL OF EXISTING PAVEMENT MARKINGS

- A. Use one of these removal methods:
 - 1. Grinding
 - 2. High pressure water spray
 - 3. Sand blasting
 - 4. Shot blasting.
- B. Use equipment specifically designed for removal of pavement marking material.

3.4 REMOVAL OF TEMPORARY PAVEMENT MARKINGS

All temporary pavement marking removal work shall be coordinated with the construction activities. Temporary pavement markings shall be removed in advance of the traffic shift unless otherwise approved by the Engineer. Temporary pavement markings shall be removed during the same day or days that the traffic shift is accomplished, just prior to the traffic shift.

END OF SECTION

SECTION 32 31 00**FENCES AND GATES****PART I - GENERAL****1.1 SUMMARY**

A. Description

The work in this Section includes furnishing and installing permanent chain link fencing and gates, including grounding, and furnishing and installing temporary security fencing.

1.2 REFERENCES

<u>Sponsor</u>	<u>Number</u>	<u>Subject</u>
ASTM	A 116	Specification for Zinc-Coated (Galvanized) Steel Woven Wire Fence Fabric
ASTM	A6	General Requirements for Rolled Steel Plates, Shapes, Sheet Piling, and Bars for Structural Purposes
ASTM	A 121	Specification for Zinc-Coated (Galvanized) Steel Barbed Wire
ASTM	A 123	Specification for Zinc (Hot Galvanized) Coatings On Products
ASTM	A 153	Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM	A 392	Specification for Zinc-Coated Chain Link Fence Fabric
ASTM	A500	Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM	A 53	Specification for Structural Steel Pipe
ASTM	A 641	Zinc-Coated (Galvanized) Carbon Steel Wire
ASTM	A 702	Specification for Steel Fence Posts and Assemblies, Hot Wrought
ASTM	A 824	Specification for Metallic-Coated Steel Marverled Tension Wire for Use with Chain Link Fence
ASTM	F 567	Practice for Installation of Chain Link Fence
ASTM	F 626	Specification for Fence Fittings
ASTM	F 668	Specification for Poly (Vinyl Chloride) (PVC) - Coated Steel Chain Link Fence Fabric
ASTM	F 669	Specification for Strength Requirements of Metal Posts and Rails for Industrial Chain Link Fence
ASTM	F 900	Specification for Industrial and Commercial Swing Gates
ASTM	F 1083	Specification for Pipe, Steel, Hot-Dipped Zinc Coated (Galvanized) Welded, for Fence Structures

FS	RR-F-191/1	Fencing, Wire and Post, Metal (Chain Link Fence Fabric) (Detail Specification) - Type IV.
FS	FF-P-101	Padlocks
CLFMI	Standards	Chain Link Fence Manufacturers Institute Standards

1.3 SUBMITTALS

- A. Submittals shall be made in accordance with the requirements of the Project Quality Plan, except as modified herein.
- B. Submit product data including manufacturer's data, specifications and installation instructions.
- C. Submit Shop Drawings which show details of fabrication and installation.
- D. Submit complete materials list and detailed fabrication drawings for gates and frames including structural calculations as required.

1.4 QUALITY CONTROL

Comply with CLFMI Standards and manufacture a complete system produced by a single manufacturer including necessary fittings and fastenings.

PART II - PRODUCTS

2.1 CHAIN LINK FENCE MATERIALS (2 INCH Galvanized)

- A. Fabric
 - 1. Galvanized Steel Wire: ASTM A 392, 2.0 oz/ft² of zinc after weaving.
 - 2. Helically wound and woven to height indicated on drawings, 2 inch diamond mesh of 9 gauge wire.
 - 3. Selvage of fabric shall be knuckled top and bottom.
 - 4. Provide one-piece fabric widths.
- B. Framing
 - 1. Steel Pipe: ASTM F 669 standard weight schedule 40.
 - 2. Hot dipped galvanized with minimum average 1.8 oz ft² zinc.
- C. Gates
 - 1. Horizontal and vertical members of gates shall be fabricated for gate operation and attachment of fabric, hardware and accessories.
 - 2. Fabricate gate perimeter frames of steel pipe, in size required above, galvanized.

3. Assemble gage frames by welding or with special fittings and rivets, for rigid connections.
4. Install fabric with stretcher bars at vertical edges and top and bottom edges.
5. Attach hardware to provide security against removal or breakage.
6. Hinges shall be size and material to suite gage size, non-lift-off type, offset to permit maximum degree of gate opening. Provide sufficient hinges for each leaf to support gage without excessive sagging, minimum of 1-½ pair of hinges per leaf, unless otherwise noted. Attach chain link fence fabric to the gate frame with stretcher bars and tie wires as specified for the fence construction, and provide suitable tension connections spaced at approximately one foot intervals.
7. Latch shall be forked type or plunger-bar type to permit operation from either side of gate, with padlock eye as integral part of latch. Provide padlocks conforming to FS FF-P-101, Type EPC, two inch size, solid brass case, with chain. Provide one padlock with chain for each gate. Key padlocks alike and master-key to KCMO system locks as required by the KCMO or its designee.
8. Provide adequate bracing. Provide gates capable of being opened and closed easily by one person. Provide with locking latches and a plunger-bar arranged to engage the center stop. Use center stops consisting of a device arranged to be set in concrete and to engage a plunger bar of the latch. Use keeper consisting of a mechanical device for securing the free end of the gate when in the full open position.

D. Accessories

1. Chain link fence accessories shall conform to ASTM F 626. Provide all items necessary to complete fence system. Galvanize and coat each ferrous metal item in accordance with ASTM A 153 and finish to match framing and fabric.
2. Tension wire shall be galvanized and coated seven gage coiled spring wire. Finish shall match fabric.
3. Post Caps shall be pressed steel, wrought iron, or malleable iron, finished to match fabric and posts designed as a watertight closure cap, with openings to permit through passage of top rail. Provide one cap for each post.
4. Tension (stretcher) bars shall be one piece lengths equal to full height of fabric, with a minimum cross-section of $\frac{3}{16}$ " by $\frac{3}{4}$ " with the same galvanizing as the fabric. Provide tension (stretcher) bars where chain link fabric meets terminal posts.
5. Tension (stretcher bar) bands shall be pressed steel spaced not over 15" on center to secure tension (stretcher) bars to end, corner, pull, and gate posts.
6. Provide one stretcher bar for each end post, and two for each corner and pull post, except where fabric is integrally woven into the post.
7. Wire ties and clips shall be 9 gauge galvanized steel for attachment of fabric to line posts. Double wrap 13 gauge for rails and braces. Hog ring ties of 11 gauge for attachment of fabric to tension wires.

E. Concrete shall be as specified in Section 03 30 00.

- F. Provide all other materials not specifically described, but required for a complete installation of the work described in this Section.
- G. Materials shall be new, first quality of their respective kinds, as selected by the Contractor subject to review by the Engineer.

2.2 CHAIN LINK FENCE MATERIALS (1 INCH Black Vinyl)

- A. Fabric
 - 1. Galvanized Steel Wire: ASTM A 392, 2.0 oz/ft² of zinc after weaving.
 - 2. Helically wound and woven to height indicated on drawings, 1 inch diamond mesh of 9 gauge wire.
 - 3. Selvage of fabric shall be knuckled top and bottom.
 - 4. Provide one-piece fabric widths.
 - 5. Provide black vinyl clad fabric of polyvinyl chloride thermally bonded to galvanized wire, conforming to FS RR-F-191/1, Type IV. Provide vinyl of a uniform 0.02 inch thick.
- B. Framing
 - 1. Steel Pipe: ASTM F 669 standard weight schedule 40.
 - 2. Hot dipped galvanized with minimum average 1.8 oz ft² zinc, coated and bonded with black PVC, with finish to match fabric.
- C. Gates
 - 1. Horizontal and vertical members of gates shall be fabricated for gate operation and attachment of fabric, hardware and accessories.
 - 2. Fabricate gate perimeter frames of steel pipe, in size required above, galvanized and coated in the same manner as the fabric.
 - 3. Assemble gate frames by welding or with special fittings and rivets, for rigid connections.
 - 4. Install fabric with stretcher bars at vertical edges and top and bottom edges.
 - 5. Attach hardware to provide security against removal or breakage.
 - 6. Hinges shall be size and material to suite gate size, non-lift-off type, offset to permit maximum degree of gate opening. Provide sufficient hinges for each leaf to support gate without excessive sagging, minimum of 1-½ pair of hinges per leaf, unless otherwise noted. Attach chain link fence fabric to the gate frame with stretcher bars and tie wires as specified for the fence construction, and provide suitable tension connections spaced at approximately one foot intervals.
 - 7. Latch shall be forked type or plunger-bar type to permit operation from either side of gate, with padlock eye as integral part of latch. Provide padlocks conforming to FS FF-P-101, Type EPC, two inch size, solid brass case, with chain. Provide one

padlock with chain for each gate. Key padlocks alike and master-key to KCMO system locks as required by KCMO or its designee.

8. Provide adequate bracing. Provide gates capable of being opened and closed easily by one person. Provide with locking latches and a plunger-bar arranged to engage the center stop. Use center stops consisting of a device arranged to be set in concrete and to engage a plunger bar of the latch. Use keeper consisting of a mechanical device for securing the free end of the gate when in the full open position.

D. Accessories

1. Chain link fence accessories shall conform to ASTM F 626. Provide all items necessary to complete fence system. Galvanize and coat each ferrous metal item in accordance with ASTM A 153 and finish to match framing and fabric.
2. Tension wire shall be galvanized and coated seven gage coiled spring wire. Finish shall match fabric.
3. Post Caps shall be pressed steel, wrought iron, or malleable iron, finished to match fabric and posts designed as a watertight closure cap, with openings to permit through passage of top rail. Provide one cap for each post.
4. Tension (stretcher) bars shall be one piece lengths equal to full height of fabric, with a minimum cross-section of $\frac{3}{16}$ " by $\frac{3}{4}$ " with the same galvanizing as the fabric. Provide tension (stretcher) bars where chain link fabric meets terminal posts.
5. Tension (stretcher bar) bands shall be pressed steel spaced not over 15" on center to secure tension (stretcher) bars to end, corner, pull, and gate posts.
6. Provide one stretcher bar for each end post, and two for each corner and pull post, except where fabric is integrally woven into the post.
7. Wire ties and clips shall be 9 gauge galvanized steel for attachment of fabric to line posts. Double wrap 13 gauge for rails and braces. Hog ring ties of 11 gauge for attachment of fabric to tension wires.
8. Roll type gate shall include wheel carriers, rear wheels, pipe track brackets, and latch.

E. Concrete shall be as specified in Section 03 30 00.

F. Provide all other materials not specifically described, but required for a complete installation of the work described in this Section.

G. Materials shall be new, first quality of their respective kinds, as selected by the Contractor subject to review by the Engineer.

2.3 TEMPORARY SECURITY FENCE

A. Fence Material

1. Fabric shall be galvanized steel wire chain link, as specified in Section 2.1 above
2. Framework shall be steel pipe as specified above in Section 2.1.

3. Accessories shall be as specified above in Section 2.1.
 4. Used Material for Temporary Security Fence is acceptable.
- B. Fence Panels
1. Provide 72" fence panels 10' - 12' long framed on both ends of top and bottom with 1- $\frac{3}{8}$ " diameter galvanized sheet tubing welded to form a single piece panel frame.
 2. End takes shall extend beyond the bottom of the frame 6" minimum to fit into concrete bases.
- C. Fence Fabric
1. Fabric shall be as specified herein, but need not be vinyl clad, may be a 2" diamond mesh, and shall be a single piece for each panel.
 2. Fabric shall be stretched tight between frame work and secured with metal wire, as specified, at 12" intervals and at corners all around the frame work.
- D. Concrete Bases: Provide concrete bases approximately 70 lbs., 5" high x 5" wide, and 12" long, with two holes in each for setting panel legs.
- E. Panel Clamp: Provide at least two galvanized steel saddle clamps with carriage bolts at connections between panels. Provide one at top and one at bottom of panel.

2.4 STEEL PICKET FENCES

- A. Pickets, Rails and Posts - Fabricate from cold-rolled steel, square tubing conforming to ASTM A500 or hot-rolled steel bars conforming to ASTM A6. Post caps: 3/16 inch thick flat steel plate conforming to ASTM A6 continuously welded in place; weld watertight, and grind flush and smooth. Provide round picket fence posts to interface with chain link fence where indicated on the Contract Drawings.
- B. Fabrication - Weld pickets to rails. Bolt picket panels to post. Shop-assemble fence components. Miter, cope and weld intersections. Remove spatter, grind exposed welds, and blend and contour surfaces to match adjacent surfaces.
- C. Gates and Removable Panels - Assemble in shop and ship with hardware. Gate - Welded construction with neat full weld. Locking devices - Substantially constructed, practical, and complete with hardware as required.
- D. Galvanizing - Hot-dip galvanize after fabrication in accordance with ASTM A123. Apply galvanized coating, minimum 2.0 oz./sq. ft. for posts and 1.5 oz./sq. ft. for steel pickets. Provide test coupon verifying minimum coating thickness for each panel.
- E. Finish - Black Zinc galvanized coating.
- F. Concrete, post holes and grounding system as specified for Chain Link Fence in Paragraph 2.1.
- G. Optional Finish - At Contractor's option, supply black polyvinyl chloride (PVC) coating over lightly galvanized finish.
1. Galvanize components in accordance with ASTM A123, G40, minimum.

2. Fabricated, galvanized panels - PVC coated with 10 mils black PVC thermally fused and bonded by fluidized bed method. PVC coating - In accordance with ASTM F668, Paragraphs 16.2.3 and 16.3.2 through 16.3.3 (performance criteria), and Paragraph 16.5.1 (color)
3. After installation, use PVC coating manufacturer's touch-up paint and repair PVC coating where welded, scratched, abraded, removed or otherwise damaged.
4. Weld galvanized post caps and steel plate panel connectors onto posts before applying PVC coating.

2.5 BOLLARDS

- A. Pipe: 4" diameter galvanized structural steel pipe per ASTM A53.
- B. Concrete: Class AA(AE) as specified in Section 03 15 16.
- C. Components: Galvanized structural steel per ASTM A53.

2.6 SWING TYPE GATE (VEHICULAR)

- A. Framing
 1. 2" O.D. Steel Pipe uprights for hinge and latch sides.
 2. Hot dipped galvanized with minimum average 1.80 oz ft² zinc.
 3. 1-5/8" O.D. vertical bracing, and 2" diagonal members.
 4. Vertical bracing spaced at 5' minimum increments from gate post.
- B. Gate Post
 1. 4" O.D. x 7' Steel Pipe
 2. Hot dipped galvanized with minimum average 1.80 oz ft² zinc.
- C. Accessories
 1. Aluminum Post Caps for pipe ends.
 2. Malleable butt hinges (galvanized)
 3. Gate latches (galvanized)

PART III - EXECUTION

3.1 GENERAL

- A. Verify areas to receive fencing are completed to final grades and elevations.
- B. Ensure property lines and legal boundaries of work are clearly established.

3.2 CHAIN LINK FENCING

- A. Install chain link fencing in accordance with ASTM F 567 and manufacturer's instructions.

- B. Locate terminal posts at each fence termination, change in horizontal alignment and vertical direction of 30 degrees or more.
- C. Space line posts uniformly at 10 feet on center.
- D. Concrete set terminal, line and gate posts:
 - 1. Drill holes for concrete footings for fence posts in firm, undisturbed or compacted soil. Holes shall have the minimum diameters shown on the Contract Drawings. Excavate hole depths approximately 6" lower than the post bottom, with bottom of posts set not less than 36" below the surface.
 - 2. Place concrete around posts and vibrate or tamp for consolidation.
- E. Check each post for vertical and top alignment, and hold in position during placement and finishing operations.
- F. For fencing mounted on concrete wall place fence posts in wall sleeves, check each post for vertical and top alignment. Hold in position and use Poroc grout or approved equal for setting the posts in the sleeves.
- G. Top rails shall be installed continuously through post caps. Expansion couplings as recommended by fencing manufacturer.
- H. Brace assemblies shall be installed so posts are plumb when diagonal rod is under proper tension.
- I. Tension wire shall be installed by weaving through fabric and tying to each post with not less than six gage galvanized wire, or by securing the wire to fabric. Take care not to damage wire coating.
- J. Fabric shall be installed with approximately 2" between finish grade and bottom selvage and 2" between top selvage and overhead structure. Pull fabric taut and tie to posts, rails, and tension wires. Install fabric on security side of fence, and anchor to framework so that fabric remains in tension after pulling force is released.
- K. Stretcher bars shall be threaded through or clamped to fabric at 4" on center and secure to posts with metal bands spaced 15" on center.
- L. Gates shall be installed plumb, level, and secured for full opening without interference. Adjust hardware for smooth operation.
- M. U-shaped tie wires, conforming to diameter of pipe to which attached, shall be installed with clasping pipe and fabric firmly attached with ends twisted at least two full turns. Ends of wire shall be bent to minimize hazard to persons and clothing.
- N. Fasteners shall be installed with nuts for tension bands and hardware bolts on side of fence opposite fabric side. Ends of bolts shall be peened or threads shall be scored to prevent removal of nuts.
- O. Install "no trespassing" signs on fence as indicated. Do not place manufacturer's or other signs on fence.
- P. Clean up debris and unused material, and remove from the site.

3.3 TEMPORARY SECURITY FENCE

- A. Temporary security fence shall be installed to provide a temporary barrier which will isolate the construction area from the adjacent property, whenever the Contractor's operations create a condition hazardous to traffic or to the public, in accordance with KCMO's CM/GC General Conditions.
- B. When fence panels are not used, install fence as specified above.
- C. Terminal and line posts shall be driven in ground.
- D. Upon completion of the work, the fence shall be removed and become the property of the Contractor.

3.4 STEEL PICKET FENCE

- A. Footings and Posts: Excavate holes on maximum 10 foot centers, measured parallel to slope of natural ground; do not impose on KCMO's right-of-way monuments. Install posts and pickets in vertical position. Except as otherwise indicated, grout posts in sleeves where fencing will be installed on top of concrete walls or in sidewalks. Place concrete and grout as specified in Section 03 30 00, Cast-in-Place Concrete; allow concrete and grout to cure not less than 72 hours before proceeding with work on posts. Do not place signs on fence.
- B. Rails: Install horizontally and step, as required, to adjust to variations in grade.
- C. Ground Rods: Install along fence line on nominal 500 foot centers; install rods and bond at gates. Where a power line passes over fence, install ground rod and ground well on each side of power line crossing, at fence line post nearest crossing, and install additional grounds 165 feet each side of that point. Ground end posts and posts on each side of removable access panels. Exothermically weld connecting wire to posts and ground rods; coat welds with one coat of hot coal-tar enamel.
- D. Touch-Up: After installation, repair fence where galvanizing or vinyl coating has been welded, scratched, abraded, removed, or otherwise damaged.
- E. Field Quality Control: Perform megger test between fence and absolute ground, midway between every ground rod. Measure resistance between fence and absolute ground with megger not less than 48 hours after rainfall or artificial waterings. Do not exceed two ohms resistance.
- F. Clean Up: Remove excess and waste materials from Worksite.

3.5 BOLLARDS

- A. Install per Contract Drawings.

3.6 SWING TYPE GATE (VEHICULAR)

- A. Install per manufacturers instructions with hole depth approximately 6" lower than post bottom with bottom of posts set not less than 36" below the surface. Hole shall be bell shaped (wider at the bottom). Fill hole with concrete to approximately 4"-5" below grade or ground level. Next, back fill with dirt and replumb post.
- B. Gates shall be installed, plumbed, level, and secured for full opening without interference.
- C. Clean up debris and unused material, remove from site.

PART IV - MEASUREMENT

4.1 Measurement

- A. The quantities of accepted work will be measured in the following units. All measurements will be plan measure except for authorized changes.
1. Chain Link Fence LF (Linear Foot)
 2. Chain Link Swing Gate EA (Each)

PART V - PAYMENT

5.1 Payment

Payment will be made at the respective unit or lump-sum price listed in the proposal and shall be full compensation for all labor, materials, and equipment necessary to complete the respective unit in place. There will be no separate measurement or payment for any item of work not specifically identified and listed in the proposal, and all such work shall be considered a subsidiary item with all costs pertaining thereto included in the prices for other items listed in the proposal. At the Engineer's option, partial payment may be made for any lump sum item listed in the proposal, providing that the Contractor is diligently and satisfactorily pursuing full completion of such partially complete item in accordance with the approved job progress schedule.

END OF SECTION

SECTION 32 31 16**WELDED WIRE FENCES AND GATES****PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
1. Metallic-coated-steel, welded-wire fences.
 2. Swing gates.
- B. Related Requirements:
1. Section 03 30 00 "Cast-in-Place Concrete" for concrete fill.
 2. Section 31 20 00 "Earth Moving" for site excavation, fill, and backfill where welded-wire fences and gates are located.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For gates. Include plans, elevations, sections, details, and attachments to other work.
- C. LEED Submittals:
1. Product Data for Credit MR 4.1 and Credit MR 4.2: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
 - a. Include statement indicating costs for each product having recycled content.
 2. Product Data for Credits MR 5.1 and 5.2 - Local/Regional Materials:
 - a. Indicate location of manufacturing facility, including name, address, and distance between manufacturing facility and the project site. Provide manufacturer's documentation indicating location where the base materials were extracted, mined, quarried, harvested, etc. and the distance between this location and the project site. Also include material costs, excluding cost of installation.
- D. Samples: For each fence material and for each color specified.
1. Provide Samples 12 inches (300 mm) in length for linear materials.
 2. Provide Samples 12 inches (300 mm) square for wire mesh.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For gate operators to include in maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Fabricator of products.
- B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.
 - 1. Include 10-foot (3-m) length of fence complying with requirements.
 - 2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 PROJECT CONDITIONS

- A. Existing Utilities: do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
 - 1. Notify Architect not less than two days in advance of proposed utility interruptions.
 - 2. Do not proceed with utility interruptions without Architect's written permission.
- B. Field Measurements: verify layout information for fences and gates shown on drawings in relation to property survey and existing structures. Verify dimensions by field measurements.

PART 2 - PRODUCTS

2.1 METALLIC-COATED-STEEL, WELDED-WIRE FENCES

- A. Metallic-Coated-Steel, Welded-Wire Fences:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Omega Fence Systems (www.omegafence.com)
 - b. Other manufacturer, provided they have five years or more experience manufacturing metallic coated steel welded wire fences and swing gates meeting all specifications for design, size, gauge of metal and fabrication.
- B. Model: Omega Architectural
 - 1. Height: 4 ft. (1245 mm) or 8 ft. (2464 mm), where indicated on drawings.
 - 2. Color: Black (RAL 9004).
- C. Fence Fabric: Metallic-coated-steel wire.
 - 1. Spacing of Vertical Wires: 6 inches (150 mm).
 - 2. Vertical Wire Size: 6 gauge - 0.192 inch (4.88 mm).
 - 3. Spacing of Horizontal Wires: 2 inches (50 mm).
 - 4. Horizontal Wire Size: 6 gauge - 0.192 inch (4.88 mm).
 - 5. The cold rolled wire shall have a tensile strength of at least 75,000 psi (515 Mpa)

- and a 2,172 lbs (985 Kg) break strength as per ASTM A185 & A853.
6. Panels shall have a number of folds (to add strength) according to the table below depending on the respective height of the panel. Panel camber may not exceed 0.094" (2.5 mm).

Panel		
Width [in. (mm)]	Height [in. (mm)]	Number of folds
92-3/4 (2356)	49 (1245)	2
92-3/4 (2356)	61 (1549)	2
92-3/4 (2356)	70 (1778)	3
92-3/4 (2356)	97 (2464)	4

D. Posts:

1. Square tubes, to be installed in-ground and/or a flanged application. The size and the gauge of the posts shall be as shown in the table below for the various height dimensions. Posts are cold rolled from 1008 grade steel and meet ASTM 500 and ASTM A787-01.

Typical available posts	4' Height (1245 mm)	5' Height (1549 mm)	6' Height (1778 mm)	8' Height (2464 mm)
2 x 2 (50x50) 16 Ga (1,6mm)	329	263	--	--
2 x 2 (50x50) 11 Ga (3,0mm)	578	463	385	289
3 x 3 (50x50) 11 Ga (3,0mm)	1383	1106	922	691

- a. Minimum requirement for posts per table below (length of posts are a minimum 24 in. to 36 in. [610 mm to 915 mm] longer than actual height of the fence for installation in the ground):

Square Post				Installation
Height [in. (mm)]	Type [in.]	Gauge	Weight [lbs./ft.]	Depth [in. (mm)]
72 (1829)	2 x 2	16	1.71	36 (914)
84 (2134)	2 x 2	16	1.71	36 (914)
96 (2440)	2 x 2	11	2.8	36 (914)
	3 x 3	11	4.7	36 (914)
120 (3048)	2 x 2	11	2.8	36 (914)
	3 x 3	11	4.7	36 (914)

- E. Post Caps: Aluminum castings.
- F. Fasteners: Manufacturer's standard tamperproof, corrosion-resistant, color-coated fasteners matching fence components.
- G. Finish: Powder coating.

2.2 SWING GATES

- A. Gate Configuration: As indicated on drawings.

- B. Gate Frame Height: 8 ft. (2464 mm).
- C. Gate Opening Width: As indicated on drawings.
- D. Galvanized-Steel Frames and Bracing: In accordance with ASTM F900 (1984) using galvanized square steel tube 16 ga (1.6 mm). Frame shall be fabricated from two vertical tubes of 1 1/2 in. X 1 1/2 in. (38 mm X 38 mm) (and from two horizontal tubes of 2 in. x 2 in. (50 mm X 50 mm) welded at intersections to create a rigid frame. If gate is over 8 ft. (2440 mm) high or 8 ft. (2440 mm) wide, a supplementary vertical support of 1 1/2 in. X 1 1/2 in. (38 mm X 38 mm) is needed. If gate height or width exceeds 7 ft. (2134 mm), both vertical tubes must be 11 ga (3.0 mm).
- E. Gate Posts: Cold rolled from 1008 grade steel. Posts are to include cap and attachment kit for adjacent panel mounting. Post selection per table below:

Single Frame Gate Opening	Square Post Size
6 ft. (1830 mm) or less	3 in. x 3 in. (75 mm x 75 mm)
6.1 ft. (1860 mm) to 13.5 ft. (4115 mm)	4 in. x 4 in. (100 mm x 100 mm)
13.6 ft. (4145 mm) to 16 ft. (4875 mm)	6 in. x 6 in. (150 mm x 150 mm)
16 ft. (4876 mm) and over	Custom by manufacturer

- F. Infill: Welded-wire fence fabric matching adjacent fence, see section 2.01.C.
- G. Hardware: In conformity with ASTM F900 (1984) for hinges, latch, drop rods, shall be hot-dip galvanized steel, and sized to assure proper gate operation. Non moving parts shall be powder coated.
- H. Spring Hinges: BHMA A156.17, Grade 1, suitable for exterior use.
1. Function: 320 - Gate spring pivot hinge. Adjustable tension / 321 - Gate spring pivot hinge. Fixed tension.
 2. Material: Malleable iron; galvanized.
- I. Hinges: BHMA A156.1, Grade 1, suitable for exterior use.
1. Function: 39 - Full surface, triple weight, antifriction bearing.
 2. Material: Wrought steel, forged steel, cast steel, or malleable iron; galvanized.
- J. Rim Locks: BHMA A156.5, Grade 1, suitable for exterior use.
1. Function: 621 - Latchbolt by key from outside and by turn from inside. Latchbolt is held retracted by device from inside / 622 - Deadbolt by key from outside and by turn from inside / 629 - Deadlocking latchbolt by key from outside and by turn from inside / 626 - Interlocking deadbolt operated by key from either side / 627 - Interlocking deadbolt operated by key from outside and by turn from inside.
 2. Material: Cast, forged, or extruded brass or bronze.
 3. Mounting Plate: Configuration necessary for mounting locks. Fabricate from 1/8-inch- (3.2-mm-) thick, steel plate; hot-dip galvanize after fabrication.
- K. Mortise Locks: BHMA A156.13, Grade 1, suitable for exterior use.
1. Function: F06 - Holdback lock / F07 - Storeroom or closet lock / F09 - Apartment, exit, or public toilet lock / F16 - Double-cylinder deadlock / F17 - Deadlock.
 2. Material: Brass or bronze.
 3. Levers: Cast, forged, or extruded brass or bronze.

4. Mounting Box: Configuration necessary to enclose locks. Fabricate from 1/8-inch- (3.2-mm-) thick, steel plate; hot-dip galvanize after fabrication.
- L. Electric Strikes: BHMA A156.31, Grade 1, of configuration required for use with lock specified, fail-safe/-secure, and suitable for exterior use.
 1. Mounting Plate: Configuration necessary for mounting electric strikes. Fabricate from 1/8-inch- (3.2-mm-) thick, steel plate; hot-dip galvanize after fabrication.
 2. Mounting: Mortise into post.
- M. Cane Bolts: Provide for inactive leaf of pairs of gates. Fabricated from 1/2-inch- (12.7-mm-) / 3/4-inch- (19-mm-) diameter, round steel bars, hot-dip galvanized after fabrication. Finish to match gates. Provide galvanized-steel pipe strikes to receive cane bolts in closed position / both open and closed positions.
- N. Finish exposed welds to comply with NOMMA Guideline 1, Finish #2 - completely sanded joint, some undercutting and pinholes okay / Finish #3 - partially dressed weld with splatter removed / Finish #4 - good-quality, uniform undressed weld with minimal splatter.
- O. Metallic-Coated-Steel Finish: High-performance coating / Galvanized finish.

2.3 FENCE AND GATE MATERIALS

- A. Metallic-Coated-Steel Wire: Welded-wire fence fabric, hot-dip galvanized after fabrication. Weight of zinc coating shall be not less than 1.0 oz./sq. ft. (305 g/sq. m).
- B. Plates, Shapes, and Bars: ASTM A 36/A 36M.
- C. Tubing: ASTM A 500/A 500M, cold-formed steel tubing.
- D. Uncoated Steel Sheet: Hot-rolled steel sheet, ASTM A 1011/A 1011M, Structural Steel, Grade 45 (Grade 310) or cold-rolled steel sheet, ASTM A 1008/A 1008M, Structural Steel, Grade 50 (Grade 340).
 1. Interior surface of tubes formed from uncoated steel sheet shall be hot-dip zinc coated same as exterior or coated with zinc-rich thermosetting coating to comply with ASTM F 2408.
- E. Metallic-Coated Steel Sheet: Galvanized-steel sheet or aluminum-zinc, alloy-coated steel sheet.
- F. Galvanized-Steel Sheet: ASTM A 653/A 653M, structural quality, Grade 50 (Grade 340), with G90 (Z275) coating.
- G. Aluminum-Zinc, Alloy-Coated Steel Sheet: ASTM A 792/A 792M, structural quality, Grade 50 (Grade 340), with AZ60 (AZM180) coating.
- H. Iron Castings: Either gray or malleable iron unless otherwise indicated.
 1. Gray Iron: ASTM A 48/A 48M, Class 30.
 2. Malleable Iron: ASTM A 47/A 47M.
- I. Aluminum Castings: ASTM B 26/B 26M, Alloy A356.0-T6.
- J. Galvanizing: For components indicated to be galvanized and for which galvanized coating is unspecified, hot-dip galvanize to comply with ASTM A 123/A 123M. For hardware items, hot-dip galvanize to comply with ASTM A 153/A 153M.

2.4 COATING MATERIALS

- A. Epoxy Primer for Galvanized Steel: Epoxy primer recommended in writing by topcoat manufacturer.
- B. Polyurethane Intermediate Coat and Topcoat: Complying with MPI #72 and compatible with undercoat.
- C. Zinc Coating:
 - 1. Wire mesh to be coated with 0.5 oz./sq.ft. (150 g/m²) zinc in conformity with ASTM A 641 (1989) Class 1.
 - 2. Fence posts, swing gate frame and posts are zinc coated (galvalum process) with a minimum of 0.9 oz/sq.ft. (275 g/m²) as per ASTM A653 G90.
- D. Polyester Powder Coating: Minimum 4 mils applied by an electrostatic method. Coating shall cover all surfaces of the wire and post sections. Coating shall be capable of withstanding the following tests:
 - 1. Mechanical adhesion test as per ASTM D 3359 (1990) - Method B.
 - 2. Shock resistance tests as per ASTM D 2794 (1990).
 - 3. Salt spray testing with a min. of 1,000 hrs without red rust appearance, as per ASTM B 117 (1990).
 - 4. Humidity resistance in a weather meter chamber as per ASTM D 2247 (1988).
 - 5. Exposure to ultraviolet light with exposure of 1000 hours using apparatus Type E and 63°C as per ASTM D1499.

2.5 MISCELLANEOUS MATERIALS

- A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
- B. Concrete: Normal-weight, air-entrained, ready-mix concrete complying with requirements in Section 03 30 00 "Cast-in-Place Concrete" with a minimum 28-day compressive strength of 3000 psi (20 MPa), 3-inch (75-mm) slump, and 1-inch (25-mm) maximum aggregate size or dry, packaged, normal-weight concrete mix complying with ASTM C 387/C 387M mixed with potable water according to manufacturer's written instructions.
- C. Nonshrink Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M and specifically recommended by manufacturer for exterior applications.

2.6 METALLIC-COATED-STEEL FINISHES

- A. Galvanized Finish: Clean welds, mechanical connections, and abraded areas, and repair galvanizing to comply with ASTM A 780/A 780M.
- B. Surface Preparation: Clean surfaces with nonpetroleum solvent so surfaces are free of oil and other contaminants. After cleaning, apply a conversion coating suited to the organic coating to be applied over it. Clean welds, mechanical connections, and abraded areas, and repair galvanizing to comply with ASTM A 780/A 780M.
- C. Powder Coating: Immediately after cleaning and pretreating, apply two-coat finish consisting of epoxy prime coat and TGIC polyester topcoat, with a minimum dry film thickness of 2 mils (0.05 mm) for topcoat. Comply with coating manufacturer's written instructions to achieve a minimum total dry film thickness of 4 mils (0.10 mm).

- D. High-Performance Coating: Apply epoxy primer, polyurethane intermediate coat, and polyurethane topcoat to prepared surfaces. Comply with coating manufacturer's written instructions and with requirements in SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting. Apply at spreading rates recommended by coating manufacturer.
1. Match approved Samples for color, texture, and coverage. Remove and refinish, or recoat work that does not comply with specified requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for site clearing, earthwork, pavement work, construction layout, and other conditions affecting performance of the Work.
- B. Do not begin installation before final grading is completed unless otherwise permitted by Architect.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 500 feet (152.5 m) or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.
1. Construction layout and field engineering are specified in Section 01 73 00 "Execution."

3.3 FENCE INSTALLATION

- A. Install fences according to manufacturer's written instructions.
- B. Post Excavation: Drill or hand-excavate holes for posts in firm, undisturbed soil. Excavate holes to a diameter of not less than 4 times post size and a depth of not less than 24 inches (600 mm) plus 3 inches (75 mm) for each foot (300 mm) or fraction of a foot (300 mm) that fence height exceeds 4 feet (1.2 m).
- C. Post Setting: Set posts in concrete footings at indicated spacing into firm, undisturbed soil.
1. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete or mechanical devices.
 2. Concrete Fill: Place concrete around posts / sleeves and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.
 - a. Exposed Concrete: Extend 2 inches (50 mm) above grade. Finish and slope top surface to drain water away from post.
 - b. Concealed Concrete: Stop 2 inches (50 mm) below grade as indicated on Drawings to allow covering with surface material. Slope top surface of concrete to drain water away from post.
 3. Posts Set in Concrete: Extend post to within 6 inches (150 mm) of specified excavation depth, but not closer than 3 inches (75 mm) to bottom of concrete.
 4. Posts Set into Concrete in Sleeves: Use galvanized-steel pipe sleeves with inside diameter at least 3/4 inch (20 mm) larger than outside diagonal dimension

of post, preset and anchored into concrete for installing posts.

- a. Extend posts at least 5 inches (125 mm) into sleeve.
 - b. After posts have been inserted into sleeves, fill annular space between post and sleeve with nonshrink grout, mixed and placed to comply with grout manufacturer's written instructions; shape and smooth to shed water. Finish and slope top surface of grout to drain water away from post.
5. Posts Set into Voids in Concrete: Form or core drill holes not less than 3/4 inch (20 mm) larger than outside diagonal dimension of post.
- a. Extend posts at least 5 inches (125 mm) into concrete.
 - b. Clean holes of loose material, insert posts, and fill annular space between post and concrete with nonshrink grout, mixed and placed to comply with grout manufacturer's written instructions. Finish and slope top surface of grout to drain water away from post.
6. Space posts uniformly per manufacturer instructions.

3.4 GATE INSTALLATION

- A. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation and lubricate where necessary.

3.5 ADJUSTING

- A. Gates: Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.
- B. Lubricate hardware and other moving parts.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's personnel to adjust, operate, and maintain gates.

END OF SECTION

SECTION 32 84 00**PLANTING IRRIGATION****PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
1. Piping.
 2. Encasement for piping.
 3. Manual valves.
 4. Pressure-reducing valves.
 5. Automatic control valves.
 6. Automatic drain valves.
 7. Transition fittings.
 8. Dielectric fittings.
 9. Miscellaneous piping specialties.
 10. Sprinklers.
 11. Quick couplers.
 12. Drip irrigation specialties.
 13. Controllers.
 14. Boxes for automatic control valves.

1.3 DEFINITIONS

- A. Circuit Piping: Downstream from control valves to sprinklers, specialties, and drain valves. Piping is under pressure during flow.
- B. Drain Piping: Downstream from circuit-piping drain valves. Piping is not under pressure.
- C. Main Piping: Downstream from point of connection to water distribution piping to, and including, control valves. Piping is under water-distribution-system pressure.
- D. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

1.4 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design 100 percent coverage irrigation system, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Irrigation zone control shall be automatic operation with controller and automatic control valves.
- C. Each zone shall irrigate a landscape with similar site, soil conditions and plant material with similar water needs. To the extent reasonably feasible, areas with significantly different solar exposures shall be zoned separately.
- D. Turf and non-turf areas shall be irrigated on separate zones.

- E. On steep grades, an irrigation method with a lower precipitation rate shall be used in order to minimize runoff and, to the extent feasible, these areas shall be zoned separately.
- F. Drip, micro-sprays, sprayheads and rotors shall not be combined on the same zone.
- G. The irrigation method shall be selected to correlate with the plant density. Drip irrigation or bubblers shall be used for sparsely-planted trees and shrubs, and rotors, sprayheads and multi-jet rotary nozzles shall be used for turfgrass.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Wiring Diagrams: For power, signal, and control wiring.
- C. Delegated-Design Submittal: For irrigation systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.6 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Irrigation systems, drawn to scale, on which components are shown and coordinated with each other, using input from Installers of the items involved. Also include adjustments necessary to avoid plantings and obstructions such as signs and light standards.
- B. Qualification Data: For qualified Installer.
- C. Zoning Chart: Show each irrigation zone and its control valve.
- D. Controller Timing Schedule: Indicate timing settings for each automatic controller zone.
- E. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For sprinklers controllers and automatic control valves to include in operation and maintenance manuals.

1.8 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1.9 QUALITY ASSURANCE

- A. Installer Qualifications: An employer of workers that include a certified irrigation designer qualified by The Irrigation Association, Professional Class member of the American Society of Irrigation Consultants, or Professional Technical Class member of the American Society of Irrigation Consultants.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Deliver piping with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe-end damage and to prevent entrance of dirt, debris, and moisture.
- B. Store plastic piping protected from direct sunlight. Support to prevent sagging and bending.

1.11 PROJECT CONDITIONS

- A. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:
 - 1. Notify Architect, Construction Manager, and/or Owner no fewer than two days in advance of proposed interruption of water service.
 - 2. Do not proceed with interruption of water service without Architect's, Construction Manager's, and/or Owner's written permission.

PART 2 - PRODUCTS

2.1 GENERAL EQUIPMENT SELECTION

- A. In order to reduce leakage of water from the irrigation system, a master shut-off valve shall be installed downstream of the backflow device to shut off water to the system when not operating.
- B. New irrigation controller(s) shall be "smart" controllers, using climate-based or soil moisture-based technology, selected from the Irrigation Association's current Smart Water Application Technologies (SWAT) tested products list or other similarly tested product list. Controllers must be installed and programmed according to manufacturer's specifications.
 - 1. A data input chart for the Smart Controller, including the precipitation rate from the audit, shall be posted at each irrigation controller.
 - 2. Within 6 weeks of the installation of new landscaping, the irrigation system "smart" Controllers shall be reset to the normal seasonal watering schedule.
- C. A rain sensor shall be installed on each new irrigation controller and installed according to the manufacturer's specifications.
- D. Sprinklers and nozzles shall meet the following requirements:
 - 1. The type of sprinkler and associated nozzles shall be selected to correlate with the size and geometry of the zone being irrigated.
 - 2. Sprinklers shall be spaced no closer than seventy-five (75) percent of the maximum radius of throw for the given sprinkler and nozzle. Maximum spacing shall be head-to-head coverage.
 - 3. Coverage arcs and radius of throw for turf areas shall be selected and adjusted to water only turf areas and minimize overspray onto vegetated areas, hard surfaces, buildings, fences, or other non-landscaped surfaces.
 - 4. Sprinklers, bubblers or emitters on a zone shall be of the same manufacturer.
 - 5. Sprayheads in turf areas shall have a minimum three and one-half (3½) inch pop-up riser height.
 - 6. Sprayheads on a zone shall have matched precipitation nozzles.
 - 7. Nozzles for rotors shall be selected to achieve an approximate uniform precipitation rate throughout the zone.

8. All sprayheads and rotors shall be equipped with check valves and pressure regulating stems.
- E. Pressure-compensating emitters shall be used for drip irrigation. For sloped areas, a check valve shall be installed and the drip line shall be parallel to the slope.
- F. Remote control valves shall have flow control.
- G. A backflow prevention assembly shall be installed in accordance with local codes. All backflow assemblies shall be equipped with adequately sized winterization ports downstream of the backflow assembly.

2.2 SLEEVING

- A. Separate sleeves shall be installed beneath paved areas to route each run of irrigation pipe or wiring bundle. The diameter of sleeving shall be twice that of the pipe or wiring bundle.
- B. The sleeving material beneath sidewalks, drives and streets shall be PVC Class 200 pipe with solvent welded joints.

2.3 WATER PRESSURE

- A. The irrigation system designer shall verify the existing available water pressure.
- B. The irrigation system shall be designed such that the point-of-connection design pressure, minus the possible system pressure losses, is greater than or equal to the design sprinkler operating pressure.
- C. All pop-up spray sprinkler bodies equipped with spray nozzles shall operate at no less than twenty (20) psi and no more than thirty (30) psi.
- D. All rotary sprinklers and multi-stream rotary nozzles on pop-up spray bodies shall operate at the manufacturer's specific optimum performance pressure.
- E. If the operating pressure exceeds the manufacturer's specified maximum operating pressure for any sprinkler body, pressure shall be regulated at the zone valve or sprinkler heads.
- F. Booster pumps shall be installed on systems where supply pressure does not meet the manufacturer's minimum recommended operating pressure for efficient water distribution.

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Excavating, trenching, and backfilling are specified on the Civil Drawings.

3.2 PREPARATION

- A. Set stakes to identify locations of proposed irrigation system. Obtain Architect's approval before excavation.

3.3 SYSTEM INSTALLATION

- A. Install irrigation system per industry standards, and as required in Section 1.09.

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Operational Test: After electrical circuitry has been energized, operate controllers and automatic control valves to confirm proper system operation.
 - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Any irrigation product will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

3.5 STARTUP SERVICE

- A. Perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.
 - 2. Verify that controllers are installed and connected according to the Contract Documents.
 - 3. Verify that electrical wiring installation complies with manufacturer's submittal.

3.6 ADJUSTING

- A. Adjust settings of controllers.
- B. Adjust automatic control valves to provide flow rate at rated operating pressure required for each sprinkler circuit.
- C. Adjust sprinklers and devices, except those intended to be mounted aboveground, so they will be flush with, or not more than 1/2 inch (13 mm) above, finish grade.

3.7 CLEANING

- A. Flush dirt and debris from piping before installing sprinklers and other devices.

3.8 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain automatic control valves and controllers.

END OF SECTION

SECTION 32 91 00**PLANTING PREPARATION****PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes soil preparation, planting soil stabilization, and landscape grading including the following:
1. Inorganic soil amendments.
 2. Organic soil amendments.
 3. Fertilizers.
 4. Planting soils.
 5. Erosion-control material(s).
 6. Pesticides and Herbicides.
 7. Miscellaneous products including:
 - a. Mycorrhizal fungi.
- B. Related Sections:
1. Division 31 Section "Site Clearing" for protection of existing trees and plantings, topsoil stripping and stockpiling, and site clearing.
 2. Division 31 Section "Earth Moving" for excavation, filling and backfilling, and rough grading and for subsurface aggregate drainage and drainage backfill materials.
 3. Section 32 92 00 "Prairie Grasses and Wildflowers" for prairie planting, hydromulching, and erosion-control materials.
 4. Section 32 80 00 "Irrigation " for irrigation.
 5. Section 32 93 00 "Plants" for trees.
 6. Division 33 Section "Subdrainage" for below-grade subsurface drainage of landscaped areas, paved areas, and wall perimeters.

1.3 DEFINITIONS

- A. Duff Layer: The surface layer of native topsoil that is composed of mostly decayed leaves, twigs, and detritus.
- B. Finish Grade: Elevation of finished surface of planting soil.
- C. Manufactured Topsoil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.
- D. Planting Area: Areas to be planted.
- E. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. These include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.
- F. Planting Soil: Standardized topsoil; existing, native surface topsoil; existing, in-place

surface soil; imported topsoil; or manufactured topsoil that is modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.

- G. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.
- H. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.
- I. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil, but in disturbed areas such as urban environments, the surface soil can be subsoil.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated, including soils.
- B. LEED Submittals:
 - 1. Product Data for Credits MR 5.1 and 5.2 - Local/Regional Materials:
 - a. Indicate location of manufacturing facility, including name, address, and distance between manufacturing facility and the project site. Provide manufacturer's documentation indicating location where the base materials were extracted, mined, quarried, harvested, etc. and the distance between this location and the project site. Also include material costs, excluding cost of installation.
- C. Samples for Verification: For each of the following:
 - 1. Erosion Control Blankets, Fiber Mesh, and Mats: 12 by 12 inches.
- D. Qualification Data: For qualified landscape Installer.
- E. Product Certificates: For each type of manufactured product soil amendments and fertilizers, from manufacturer, and complying with the following:
 - 1. Manufacturer's certified analysis of standard products.
 - 2. Analysis of other materials by a recognized laboratory made according to methods established by the Association of Official Analytical Chemists, where applicable.
- F. Material Test Reports: For manufactured ASTM D 5268 topsoil.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified landscape Installer whose work has resulted in successful establishment of plants.
 - 1. Professional Membership: Installer shall be a member in good standing of either the Professional Landcare Network or the American Nursery and Landscape Association.
 - 2. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
 - 3. Pesticide Applicator: State licensed, commercial.
- B. Soil-Testing Laboratory Qualifications: An independent laboratory or university laboratory, recognized by the State Department of Agriculture, with the experience and

capability to conduct the testing indicated and that specializes in types of tests to be performed.

- C. Soil Analysis: For each unamended soil type/source, furnish soil analysis and a written report by a qualified soil-testing laboratory stating percentages of organic matter; gradation of sand, silt, and clay content; cation exchange capacity; sodium absorption ratio; deleterious material; pH; and mineral and plant-nutrient content of the soil.
1. Testing methods and written recommendations shall comply with USDA's Handbook No. 60.
 2. The soil-testing laboratory shall oversee soil sampling, with depth, location, and number of samples to be taken per instructions from the Landscape Architect. A minimum of three representative samples shall be taken from varied locations for each soil to be used or amended for planting purposes.
 3. Report suitability of tested soil for plant growth.
 - a. Based upon the test results, state recommendations for soil treatments and soil amendments to be incorporated. State recommendations in weight per 1000 sq. ft. or volume per cu. yd. for nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce satisfactory planting soil suitable for healthy, viable plants.
 - b. Report presence of problem salts, minerals, or heavy metals, including aluminum, arsenic, barium, cadmium, chromium, cobalt, lead, lithium, and vanadium. If such problem materials are present, provide additional recommendations for corrective action.
- D. Preinstallation Conference: Conduct conference at Project site.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of conformance with state and federal laws, as applicable.
- B. Bulk Materials:
1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
 2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
 3. Accompany each delivery of bulk fertilizers, lime, and soil amendments with appropriate certificates.

1.7 PROJECT CONDITIONS

- A. Field Measurements: Verify actual grade elevations, service and utility locations, irrigation system components, and dimensions of plantings and construction contiguous with new plantings by field measurements before proceeding with planting work.
- B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions.

PART 2 - PRODUCTS

2.1 INORGANIC SOIL AMENDMENTS

- A. Lime: ASTM C 602, agricultural liming material containing a minimum of 80 percent calcium carbonate equivalent and as follows:
 - 1. Class: T, with a minimum of 99 percent passing through No. 8 sieve and a minimum of 75 percent passing through No. 60 sieve.
 - 2. Class: O, with a minimum of 95 percent passing through No. 8 sieve and a minimum of 55 percent passing through No. 60 sieve.
 - 3. Provide lime in form of ground dolomitic limestone.
- B. Sulfur: Granular, biodegradable, containing a minimum of 90 percent sulfur, and with a minimum of 99 percent passing through No. 6 sieve and a maximum of 10 percent passing through No. 40 sieve.
- C. Iron Sulfate: Granulated ferrous sulfate containing a minimum of 20 percent iron and 10 percent sulfur.
- D. Aluminum Sulfate: Commercial grade, unadulterated.
- E. Perlite: Horticultural perlite, soil amendment grade.
- F. Agricultural Gypsum: Minimum 90 percent calcium sulfate, finely ground with 90 percent passing through No. 50 sieve.
- G. Sand: Clean, washed, natural or manufactured, and free of toxic materials.
- H. Diatomaceous Earth: Calcined, 90 percent silica, with approximately 140 percent water absorption capacity by weight.
- I. Zeolites: Mineral clinoptilolite with at least 60 percent water absorption by weight.

2.2 ORGANIC SOIL AMENDMENTS

- A. Compost: Either Class I or Class II compost as produced by a composting facility registered with the Missouri Department of Public Health and Environment, and as follows:
 - 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to the following:
 - a. A-1 Organics: Biocomp (Class I).
 - b. A-1 Organics: Premium 3 Horticultural Grade (Class II).
 - c. B.O.S.S. Compost, Inc.: Boston Tea Compost (Class I).
 - d. B.O.S.S. Compost, Inc.: Black Tea Compost (Class II).

2.3 FERTILIZERS

- A. Slow-Release Organic Fertilizer: Subject to compliance with requirements, products that may be incorporated into the Work include:
 - 1. Biosol 6-1-3 Natural All Purpose fertilizer.
 - 2. Sustane 5-2-4 All Natural Granulated Slow Release Nitrogen fertilizer.

2.4 PLANTING SOILS

- A. Topsoil: ASTM D 5268 topsoil, with pH range of 5.5 to 7, a minimum of 6 percent organic material content; free of stones 1 inch or larger in any dimension and other extraneous materials harmful to plant growth.

1. Topsoil Source: Existing, native surface topsoil formed under natural conditions with the duff layer retained during excavation process and stockpiled on-site. Verify suitability of native surface topsoil to produce viable planting soil. Clean soil of roots, plants, sod, stones, clay lumps, and other extraneous materials harmful to plant growth.
 - a. Supplement with imported or manufactured topsoil from offsite sources when quantities are insufficient. Obtain topsoil displaced from naturally well-drained construction or mining sites where topsoil occurs at least 4 inches (100 mm) deep; do not obtain from agricultural land, bogs or marshes. Screened and free of stones 1 inch or larger in any dimension; free of roots, plants, sod, clods, clay lumps, pockets of coarse sand, paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, building debris, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, and other extraneous materials harmful to plant growth; free of obnoxious weeds and invasive plants including quackgrass, Johnsongrass, poison ivy, nutsedge, nimblewill, Canada thistle, bindweed, bentgrass, wild garlic, ground ivy, perennial sorrel, and brome grass; not infested with nematodes; grubs; or, other pests, pest eggs, or other undesirable organisms and disease-causing plant pathogens; friable and with sufficient structure to give good tilth and aeration. Continuous, air-filled, pore-space content on a volume/volume basis shall be at least 15 percent when moisture is present at field capacity. Soil shall have a field capacity of at least 15 percent on a dry weight basis.
- B. Planting Soil: Mix topsoil with the following soil amendments and fertilizers in the following quantities to produce planting soil:
 1. Ratio of Loose Compost to Topsoil by Volume: 4 yds. / 1000 sq.ft.
 2. Based upon the Soil Analysis results and recommendations: Nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce satisfactory planting soil suitable for healthy, viable plants.

2.5 MISCELLANEOUS PRODUCTS

- A. Mycorrhizal Inoculum shall be AM 120 Standard, or approved equal:
 1. 100% Glomus intraradices (UT isolate)(120 propagules per c.c. or 100 propagules per gr.)

2.6 PESTICIDES/HERBICIDES

- A. Pesticide: Registered and approved by EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.
 1. Selection of Pesticide shall be contingent on, but not limited to, the following:
 - a. Identification of specific pest(s) to be prevented, destroyed, repelled, or mitigated.
- B. Pre-Emergent Herbicide (Selective and/or Non-Selective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.
 1. Selection of Pre-Emergent Herbicide(s) shall be contingent on, but not limited to,

the following:

- a. Identification of specific weed(s) to be eradicated.
 - b. Identification of growth rate (at the time of application) required for herbicide to be effective, specific to each type of weed.
 - c. Location of weeds (slope, exposure, etc.).
 - d. Hydrology of the area (i.e., limitations due to possible contamination to wetlands, subsurface water sources, etc.).
 - e. Soil type(s).
 - f. Application type (spot versus broadcast).
- C. Post-Emergent Herbicide (Selective and/or Non-Selective): Effective for controlling weed growth that has already germinated.
1. Selection of Post-Emergent Herbicide(s) shall be contingent on, but limited to, the following:
 - a. Identification of specific weed(s) to be eradicated.
 - b. Identification of growth rate (at the time of application) required for herbicide to be effective, specific to each type of weed.
 - c. Location of weeds (slope, exposure, etc.).
 - d. Hydrology of the area (i.e., limitations due to possible contamination to wetlands, subsurface water sources, etc.).
 - e. Soil type(s).
 - f. Application type (spot versus broadcast).
 - g. Identification of plants to be saved.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to be planted for compliance with requirements and other conditions affecting installation and performance.
1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
 2. Do not mix or place soils and soil amendments in frozen, wet, or muddy conditions.
 3. Suspend soil spreading, grading, and tilling operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
 4. Uniformly moisten excessively dry soil that is not workable and which is too dusty.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Architect and replace with new planting soil.

3.2 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities, trees, shrubs, turf areas, and existing plantings from damage caused by planting operations.
1. Protect grade stakes set by others until directed to remove them.
- B. Install erosion-control measures to prevent erosion or displacement of soils and

discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.3 PESTICIDE/HERBICIDE APPLICATION

- A. Apply pesticides, herbicides and other chemical products and biological control agents in accordance with requirements of authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.
- B. Pre-Emergent Herbicides (Selective and/or Non-Selective): Apply in accordance with manufacturer's written recommendations.
- C. Post-Emergent Herbicides (Selective and/or Non-Selective): Apply only as necessary to treat already-germinated weeds and in accordance with manufacturer's written recommendations.

3.4 PLANTING AREA PREPARATION AND ESTABLISHMENT

- A. Limit subgrade preparation to areas to be planted.
- B. Newly Graded Subgrades: Loosen subgrade to a minimum depth of 12 inches. Remove stones larger than 1 inch in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.
 - 1. Spread topsoil, apply soil amendments and fertilizer on surface, and thoroughly blend planting soil.
 - a. Delay mixing fertilizer with planting soil if planting will not proceed within a few days.
 - b. If lime application is required, mix with dry soil before mixing fertilizer.
 - 2. Spread planting soil to a depth of 6 inches but not less than required to meet finish grades after light rolling and natural settlement. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet.
 - a. Where planting soil depth is less than 8 inches, spread approximately 1/2 the thickness of planting soil over loosened subgrade. Mix thoroughly into top 4 inches of subgrade. Spread remainder of planting soil.
- C. Unchanged Subgrades: If planted areas are in areas unaltered or undisturbed by excavating, grading, or surface-soil stripping operations, prepare surface soil as follows:
 - 1. Remove existing grass, vegetation, and turf. Do not mix into surface soil.
 - 2. Loosen surface soil to a depth of at least 8 inches. Apply soil amendments and fertilizers according to planting soil mix proportions and mix thoroughly into top 6 inches of soil. Till soil to a homogeneous mixture of fine texture.
 - 3. Remove stones larger than 1 inch in any dimension and sticks, roots, trash, and other extraneous matter.
 - 4. Legally dispose of waste material, including grass, vegetation, and turf, off Owner's property.
- D. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Grade to within plus or minus 1/2 inch of finish elevation. Roll and rake, remove ridges, and fill depressions to meet finish grades. Limit finish grading to areas that can be planted in the immediate future.
- E. Before planting, obtain Landscape Architect's acceptance of finish grading; restore

planting areas if eroded or otherwise disturbed after finish grading.

- F. Apply Mycorrhizal Inoculum, per manufacturer's recommendations, at a rate of 60lbs. per acre (67.5 kg/ha)/1.4 lbs. per 1,000 ft²(0.7 kg / 100 m²), by the following methods (as applicable):
1. Seed Drilling: Incorporate into the soil at a depth ranger at or below the seed.
 2. Broadcast and Till: Evenly distribute across seedbed after seeding. Cover the exposed seed and inoculum by harrowing, chain dragging or applying an organic topdressing. Do not leave inoculum exposed to sunlight for more than four hours.
 3. Nursery Medium: Evenly blend at 5 lbs per yd³ (3 kg. Per m³). 1 lb. (454 grams) contains approximately 60,000 living propagules. Rate provides 300,000 living propagules per yd³ (396,000 living propagules per m³) or 6.5 living propagules per in³.

3.5 CLEANUP AND PROTECTION

- A. During planting, keep adjacent paving and construction clean and work area in an orderly condition.

3.6 DISPOSAL

- A. Remove surplus soil and waste material including excess subsoil, unsuitable soil, trash, and debris and legally dispose of them off Owner's property.

END OF SECTION

SECTION 32 92 00**PRAIRIE GRASSES AND WILDFLOWERS****PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes prairie grasses and wildflowers.
- B. Related Sections:
 - 1. Division 31 Section "Site Clearing" for topsoil stripping and stockpiling.
 - 2. Division 31 Section "Earth Moving" for excavation, filling and backfilling, and rough grading.
 - 3. Section 32 01 90 "Operation And Maintenance Of Planting" for maintenance instructions and pesticide application.
 - 4. Section 32 91 00 "Planting Preparation" for soil preparation, planting soil stabilization, and landscape grading.
 - 5. Section 32 93 00 "Plants" for trees.

1.3 DEFINITIONS

- A. Duff Layer: The surface layer of native topsoil that is composed of mostly decayed leaves, twigs, and detritus.
- B. Finish Grade: Elevation of finished surface of planting soil.
- C. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or top surface of a fill or backfill before planting soil is placed.
- D. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.
- E. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil, but in disturbed areas such as urban environments, the surface soil can be subsoil.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
 - 1. Pesticides and Herbicides: Include product label and manufacturer's application instructions specific to this Project.
 - 2. Imported topsoil, organic matter, and fertilizers: Include product label and manufacturer's application instructions specific to this Project.
 - 3. Fiber mulch: Include product label and manufacturer's application instructions specific to this Project.
 - 4. Mycorrhizal Inoculum: Include product label and manufacturer's application instructions specific to this Project.

- B. Certification of Grass Seed: From seed vendor for each grass-seed monostand or mixture stating the botanical and common name, percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.
- C. Qualification Data: For qualified landscape Installer.

1.5 QUALITY ASSURANCE

- A. Quality of Materials: Seed materials shall be subject to inspection and approval.
 - 1. Architect reserves the right to reject, at any time or place prior to acceptance, work and seed which in the Architect's opinion fails to meet these Specification requirements.
 - 2. Owner's Representative may make inspection periodically during seeding, at completion and at the end of warranty periods.
- B. Installer Qualifications: A qualified landscape Installer whose work has resulted in successful prairie establishment.
 - 1. Professional Membership: Installer shall be a member in good standing of either the Professional Landcare Network or the American Nursery and Landscape Association.
 - 2. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
- C. Preinstallation Conference: Conduct conference at Project site.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Seed:
 - 1. Deliver seed in sealed standard containers, with seed tags stating scientific and variety name of all species, % germination, year of preparation for seeding, name of project and acreage to be seeded by this shipment and mixture of seed.
 - 2. Seed damaged in transit or storage will not be accepted.
 - 3. Notify Architect of delivery schedule in advance so that material may be inspected upon arrival at the project site as required. Seed tags are to be given to the Landscape Architect, Ecologist or Project supervisor.
 - 4. Unacceptable material shall be removed immediately from project site.
- B. Chemical Fertilizer:
 - 1. Deliver chemical fertilizer to site in original unopened container bearing manufacturer's guaranteed chemical analysis, name, trade name, trademark and conformance to State law, bearing name and warranty of producer.
- C. Bulk Materials:
 - 1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing grassed areas or plants.
 - 2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.

1.7 PROJECT CONDITIONS

- A. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with initial maintenance periods to provide required maintenance from date of Substantial Completion.
 - 1. Spring Planting: April 1 – June 30. Adjust for weather limitations and freezing conditions.
 - 2. Fall Planting: September 1 – November 30. Adjust for weather limitations and freezing conditions.
- B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions.
- C. Pesticide/Herbicide Coordination: If applicable, delay planting until each pesticide/herbicide is inactive, as recommended by the manufacturer.

1.8 WARRANTY

- A. Seeded areas shall be warranted for one growing season to be in a healthy vigorous growing condition.
- B. During original warranty period, seeded areas that die due to natural causes, failure of germination, erosion, etc., or in opinion of Architect are unhealthy, shall be replaced.
- C. Such replacements shall be installed as specified, equal to original planting.
- D. Should settling occur, fill and compact settled areas and reseed affected areas per grading and landscape plan.

PART 2 - PRODUCTS

2.1 FERTILIZER

- A. Slow-Release Organic Fertilizer: Subject to compliance with requirements, products that may be incorporated into the Work include:
 - 1. Biosol 6-1-3 Natural All Purpose fertilizer.
 - 2. Sustane 5-2-4 All Natural Granulated Slow Release Nitrogen fertilizer.

2.2 MULCH

- A. Bedding Straw:
 - 1. Bedding straw shall be provided in 40-50 lb. bales, free of any materials considered sources of weed seed. No hay shall be used for any purpose on the project site. All straw shall be certified noxious weed free.
- B. High Performance Flexible Growth Medium:
 - 1. High Performance Flexible Growth Medium (HP-FGM) shall be hydraulically-applied, 100% biodegradable, manufactured in the United States and is composed of 100% recycled thermally refined (within a pressure vessel) wood fibers, crimped interlocking man-made biodegradable fibers, micro-pore granules, naturally derived crosslinked biopolymers and water absorbents. HP-FGM shall be phytosanitized, free from plastic netting, requires no curing period and upon application forms an intimate bond with the soil surface to create a

continuous, porous, absorbent and flexible erosion resistant blanket that allows rapid germination and accelerated plant growth.

- a. Preferred Manufacturer/Product:
Flexterra HP-FGM, by Profile Products, or approved equal.

2.3 MYCORRHIZAL INOCULUM

- A. Mycorrhizal Inoculum shall be AM 120 Standard, or approved equal:
 1. 100% Glomus intraradices (UT isolate)(120 propagules per c.c. or 100 propagules per gr.)

2.4 SCHEDULE OF PRAIRIE GRASSES AND WILDFLOWER SEED MIXTURES:

- A. Per Drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to be planted for compliance with requirements and other conditions affecting performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Architect and replace with new planting soil.

3.2 PREPARATION

- A. Decompact any construction traffic, or staging areas prior to topsoiling by tilling to 12 inches.
- B. Layout of seeding areas is indicated on the Drawings. Verify locations with Landscape Architect, Ecologist or Project Supervisor prior to starting seeding operations.
- C. Base Preparation/Grading:
 1. Protect existing surface and underground features and improvements from damage.
 2. Restore seed areas to specified condition if damaged after finish grading. No seeding shall occur until the Architect has accepted the base preparation.
 3. Protect grade stakes set by others until directed to remove them.
- D. See Division 32 Section "Planting Preparation" for soil preparation, planting soil stabilization, and landscape grading.
- E. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

3.3 FERTILIZING

- A. Apply fertilizer as specified in Section 32 91 00 Planting Preparation. Biosol is the preferred fertilizer for native seeded areas and it should be applied prior to hydromulching. All seeding types, except Type 2 Upland Prairie Seed Mixture, shall have Biosol applied at a rate of 1200 pounds/acre. Type 2 Upland Prairie Seed Mixture shall have Biosol applied at a rate of 800 pounds/acre.

3.4 SEEDING

- A. Drill seeded areas shall use a Truax or other native grass drill with separate seed boxes for different seed sizes, agitators in the boxes, Coulter wheels, depth bands, seed rows no wider than 7 inches. Seed shall be drilled in two applications at 90 degrees to each other, 50 percent plus or minus of seed applied in each pass using a Brillion seed application or approved equal.
1. Seed shall be drilled parallel to the slope in the final pass.
 2. Set depth bands to 1/4 to 1/3 inch depth. Seed shall be drilled in such a manner that after surface is raked and rolled, seed shall have about 1/4 of cover.
 3. Seed shall not be drilled during windy weather or when ground is frozen or snow covered or untillable.
 4. Seeding schedule to be coordinated with Owner, Contractor and Architect to ensure optimal success.
 5. Rake seeded areas to ensure good soil contact, raking always in direction perpendicular to slope of the land.
 6. Application Rate: shall be as indicated on the seed mix tables.
- B. Areas inaccessible to drilling equipment may be seeded by broadcasting using a mechanical spreader or by hand.
1. Rake to cover seed with 1/4 to 1/3 inch soil.
 2. Application Rate: shall be two times the drill seed rate.

3.5 MULCHING

- A. Slopes < 5:1:
1. Protect seeded areas by spreading straw mulch. Spread uniformly at a minimum rate of 2 tons/acre (42 kg/92.9 sq. m) to form a continuous blanket 1-1/2 inches (38 mm) in loose thickness over seeded areas. Spread by hand, blower, or other suitable equipment.
 - a. Anchor straw mulch by crimping into soil with suitable mechanical equipment.
- B. Slopes \geq 5:1 :
1. High Performance Flexible Growth Medium (HP-FGM) to be applied to seeded areas where slopes are greater than or equal to (\geq) 5:1. Apply HP-FGM at the following application rates:
 - a. \leq 5:1 slope: 2,500 pounds per acre.
 - b. > 5:1 slope and \leq 3:1 slope: 3,000 pounds per acre.
 - c. \geq 3:1 slope and \leq 2:1 slope: 3,500 pounds per acre.
- C. Hydromulching shall not be done during or after rainstorms, when water is standing or when runoff is occurring or when below freezing, or in the presence of snow.

3.6 MYCORRHIZAL INOCULUM

- A. Apply Mycorrhizal Inoculum, per manufacturer's recommendations, at a rate of 60lbs. per acre (67.5 kg/ha)/1.4 lbs. per 1,000 ft²(0.7 kg / 100 m²), by the following methods (as applicable):
1. Seed Drilling: Incorporate into the soil at a depth ranger at or below the seed.

2. Broadcast and Till: Evenly distribute across seedbed after seeding. Cover the exposed seed and inoculum by harrowing, chain dragging or applying an organic topdressing. Do not leave inoculum exposed to sunlight for more than four hours.
3. Nursery Medium: Evenly blend at 5 lbs per yd³ (3 kg. Per m³). 1 lb. (454 grams) contains approximately 60,000 living propagules. Rate provides 300,000 living propagules per yd³ (396,000 living propagules per m³) or 6.5 living propagules per in³.

3.7 MAINTENANCE AND ACCEPTANCE

- A. Maintenance period shall begin immediately after each area is seeded, and continue until final acceptance of landscaping work. Upon acceptance of landscaping work, the maintenance period shall extend to 30 days from the delivery date of the project.
- B. During this time water, mow, spot spray with approved herbicides (after seedlings are no longer sensitive to them), hand weed, as necessary to insure that seeded areas are in a vigorous growing condition until final acceptance.
- C. Bare areas over 1 square feet in size shall be reseeded and mulched if they fail to establish at least 6 desirable seedlings/sq. ft. (non-irrigated areas) or 12 desirable seedlings/sq. ft. (irrigated areas). The Landscape Architect or Ecologist will direct Contractor on what areas need to be reseeded during establishment inspection approximately 30 days after seeding (June-September).
- D. Seeded areas shall be mowed for annual weed control, if so directed by the Landscape Architect, at a height of not less than 3 inch and otherwise maintained until there is an acceptable uniform plant growth. A small tractor or mower shall be used to reduce possible crushing of seedling grasses and rutting of soil.
- E. Areas that are irrigated and are not producing a uniform plant growth within 30 days following first seeding, as determined by establishment inspection, shall be reseeded.
- F. Acceptable uniform plant growth shall be defined as the following, whichever is the more strict:
 1. 70% of predisturbance vegetative cover.
 2. At least 6 desirable seedlings/sq. ft. (non-irrigated areas) or 12 desirable seedlings/sq. ft. (in irrigated areas). Scattered bare spots, no greater than 1 sq. ft. and not exceeding 5 percent of seeded area may be acceptable, if approved by Landscape Architect or Ecologist.

3.8 CLEANING

- A. After completion, objects or debris which may interfere with maintenance operation shall be removed.
- B. Paved areas over which operations have been conducted shall be cleaned.
- C. Remove excess mulch from trees, shrubs and sod to prevent damage.

END OF SECTION

SECTION 32 93 00**PLANTS****PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
1. Plants.
 2. Mulching.
 3. Tree stabilization.
- B. Related Sections:
1. Division 31 Section "Site Clearing" for protection of existing trees and plantings, topsoil stripping and stockpiling, and site clearing.
 2. Division 31 Section "Earth Moving" for excavation, filling, and rough grading and for subsurface aggregate drainage and drainage backfill materials.
 3. Section 32 01 90 "Operation And Maintenance Of Planting" for maintenance instructions and pesticide application.
 4. Section 32 91 00 "Planting Preparation" for soil preparation, planting soil stabilization, and landscape grading.
 5. Section 32 92 00 "Prairie Grasses and Wildflowers" for prairie planting and erosion-control materials.
 6. Division 33 Section "Subdrainage" for below-grade drainage of landscaped areas, paved areas, and wall perimeters.

1.3 DEFINITIONS

- A. Backfill: The earth used to replace or the act of replacing earth in an excavation.
- B. Balled and Burlapped Stock: Plants dug with firm, natural balls of earth in which they were grown, with ball size not less than diameter and depth recommended by ANSI Z60.1 for type and size of plant required; wrapped with burlap, tied, rigidly supported, and drum laced with twine with the root flare visible at the surface of the ball as recommended by ANSI Z60.1.
- C. Bare-Root Stock: Plants with a well-branched, fibrous-root system developed by transplanting or root pruning, with soil or growing medium removed, and with not less than minimum root spread according to ANSI Z60.1 for type and size of plant required.
- D. Container-Grown Stock: Healthy, vigorous, well-rooted plants grown in a container, with a well-established root system reaching sides of container and maintaining a firm ball when removed from container. Container shall be rigid enough to hold ball shape and protect root mass during shipping and be sized according to ANSI Z60.1 for type and size of plant required.
- E. Duff Layer: The surface layer of native topsoil that is composed of mostly decayed leaves, twigs, and detritus.

- F. Finish Grade: Elevation of finished surface of planting soil.
- G. Planting Area: Areas to be planted.
- H. Plant; Plants; Plant Material: These terms refer to vegetation in general, including trees, shrubs, vines, ground covers, ornamental grasses, bulbs, corms, tubers, or herbaceous vegetation.
- I. Root Flare: Also called "trunk flare." The area at the base of the plant's stem or trunk where the stem or trunk broadens to form roots; the area of transition between the root system and the stem or trunk.
- J. Stem Girdling Roots: Roots that encircle the stems (trunks) of trees below the soil surface.
- K. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.
- L. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.
- M. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil; but in disturbed areas such as urban environments, the surface soil can be subsoil.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated, including soils.
 - 1. Plant Materials: Include quantities, sizes, quality, and sources for plant materials.
 - 2. Plant Photographs: Include color photographs in digital format of each required species and size of plant material as it will be furnished to the Project. Take photographs from an angle depicting true size and condition of the typical plant to be furnished. Include a scale rod or other measuring device in each photograph. For species where more than 20 plants are required, include a minimum of three photographs showing the average plant, the best quality plant, and the worst quality plant to be furnished. Identify each photograph with the full scientific name of the plant, plant size, and name of the growing nursery.
- B. LEED Submittals:
 - 1. Product Data for Credits MR 5.1 and 5.2 - Local/Regional Materials:
 - a. Indicate location of manufacturing facility, including name, address, and distance between manufacturing facility and the project site. Provide manufacturer's documentation indicating location where the base materials were extracted, mined, quarried, harvested, etc. and the distance between this location and the project site. Also include material costs, excluding cost of installation.
- C. Samples for Verification: For each of the following:
 - 1. Organic Compost Mulch: 1-quart volume sample of each organic mulch required; in sealed plastic bags labeled with composition of materials by percentage of weight and source of mulch. Each Sample shall be typical of the lot of material to be furnished; provide an accurate representation of color, texture, and organic makeup.

- D. Qualification Data: For qualified landscape Installer.
- E. Product Certificates: For each type of manufactured product, from manufacturer, and complying with the following:
 - 1. Manufacturer's certified analysis of standard products.
 - 2. Analysis of other materials by a recognized laboratory made according to methods established by the Association of Official Analytical Chemists, where applicable.
- F. Warranty: Sample of special warranty.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified landscape Installer whose work has resulted in successful establishment of plants.
 - 1. Professional Membership: Installer shall be a member in good standing of either the Professional Landcare Network or the American Nursery and Landscape Association.
 - 2. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
- B. Provide quality, size, genus, species, and variety of plants indicated, complying with applicable requirements in ANSI Z60.1.
- C. Measurements: Measure according to ANSI Z60.1. Do not prune to obtain required sizes.
 - 1. Trees and Shrubs: Measure with branches and trunks or canes in their normal position. Take height measurements from or near the top of the root flare for field-grown stock and container grown stock. Measure main body of tree or shrub for height and spread; do not measure branches or roots tip to tip. Take caliper measurements 6 inches above the root flare for trees up to 4-inch caliper size, and 12 inches above the root flare for larger sizes.
 - 2. Other Plants: Measure with stems, petioles, and foliage in their normal position.
 - 3. Plant Material Observation: Architect may observe trees and shrubs either at place of growth or at site before planting for compliance with requirements for genus, species, variety, size, and quality. Landscape Architect retains right to observe trees and shrubs further for size and condition of balls and root systems, insects, injuries, and latent defects and to reject unsatisfactory or defective material at any time during progress of work. Remove rejected trees or shrubs immediately from Project site.
 - a. Notify Landscape Architect of sources of planting materials seven days in advance of delivery to site. Arrange visit with Landscape Architect to nursery or source of plant material to inspect plant material for approval prior to delivery to site.
 - b. Arrange visit with Landscape Architect to site to inspect plant material for approval prior to planting. Advise Landscape Architect five to seven days advance notice for site visit
- D. Preinstallation Conference: Conduct conference at Project site.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Packaged Materials: Deliver packaged materials in original, unopened containers

showing weight, certified analysis, name and address of manufacturer, and indication of conformance with state and federal laws if applicable.

- B. Bulk Materials:
1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
 2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
 3. Accompany each delivery of bulk fertilizers and soil amendments with appropriate certificates.
- C. Deliver bare-root stock plants freshly dug. Immediately after digging up bare-root stock, pack root system in wet straw, hay, or other suitable material to keep root system moist until planting.
- D. Do not prune trees and shrubs before delivery. Protect bark, branches, and root systems from sun scald, drying, wind burn, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees or shrubs in such a manner as to destroy their natural shape. Provide protective covering of plants during shipping and delivery. Do not drop plants during delivery and handling.
- E. Handle planting stock by root ball. Protect stems and trunks from damage due to transport and lifting.
1. Do not drop plants. Do not lift plants by the trunk, stems, or foliage. Handle plants by the ball or the container.
 2. Reject balled plants if the ball is broken or the trunk is loose in the ball.
 3. Protect plants at all times from drying out or injury.
 4. Minor broken and damaged roots shall be pruned before planting. Major damage shall be cause for rejection as determined by the Project Manager.
- F. Store bulbs, corms, and tubers in a dry place at 60 to 65 deg F until planting.
- G. Deliver plants after preparations for planting have been completed, and install immediately. If planting is delayed more than six hours after delivery, set plants and trees in their appropriate aspect (sun, filtered sun, or shade), protect from weather and mechanical damage, and keep roots moist.
1. Heel-in bare-root stock. Soak roots that are in dry condition in water for two hours. Reject dried-out plants.
 2. Set balled stock on ground and cover ball with soil, peat moss, sawdust, or other acceptable material.
 3. Do not remove container-grown stock from containers before time of planting.
 4. Water root systems of plants stored on-site deeply and thoroughly with a fine-mist spray. Water as often as necessary to maintain root systems in a moist, but not overly-wet condition.

1.7 PROJECT CONDITIONS

- A. Field Measurements: Verify actual grade elevations, service and utility locations, irrigation system components, and dimensions of plantings and construction contiguous with new plantings by field measurements before proceeding with planting work.

- B. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with maintenance periods to provide required maintenance from date of Substantial Completion.
 - 1. Spring Planting: April 1 – June 30. Adjust for weather limitations and freezing conditions.
 - 2. Fall Planting: September 1 – November 30. Adjust for weather limitations and freezing conditions.
- C. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions and warranty requirements.
- D. Coordination with Prairie Areas (Meadows): Plant trees, shrubs, and other plants after finish grades are established and before planting prairie areas unless otherwise indicated.
 - 1. When planting trees, shrubs, and other plants after planting turf areas, protect prairie areas, and promptly repair damage caused by planting operations.

1.8 WARRANTY

- A. Special Warranty: Installer agrees to repair or replace plantings and accessories that fail in materials, workmanship, or growth within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Death and unsatisfactory growth, except for defects resulting from abuse, lack of adequate maintenance, or neglect by Owner, or incidents that are beyond Contractor's control.
 - b. Structural failures including plantings falling or blowing over.
 - c. Faulty performance of tree stabilization.
 - 2. Warranty Periods from Date of Substantial Completion:
 - a. Trees, Shrubs, Vines, and Ornamental Grasses: 12 months.
 - b. Prairie Areas, Ground Covers, Perennials, and Other Plants: 12 months.
 - 3. Include the following remedial actions as a minimum:
 - a. Immediately remove dead plants and replace unless required to plant in the succeeding planting season.
 - b. Replace plants that are more than 25 percent dead or in an unhealthy condition at end of warranty period.
 - c. A limit of one replacement of each plant will be required except for losses or replacements due to failure to comply with requirements.
 - d. Provide extended warranty for period equal to original warranty period, for replaced plant material.

PART 2 - PRODUCTS

2.1 LOCAL / REGIONAL MATERIALS

- A. Preference shall be given to suppliers whose facilities are within a 500 mile radius of the project site.
- B. Preference shall be given to plant suppliers who provide:
 - 1. Native plant species that are locally grown

2. Naturalized plant species that are regionally grown
 3. Non-native adapted plant species that are acclimated at the nursery for an appropriate period of time prior to planting.
- C. Preference shall be given to materials that are harvested, extracted, mined, quarried, etc. within a 500 mile radius of the project site.

2.2 PLANT MATERIAL

- A. General: Furnish nursery-grown plants true to genus, species, variety, cultivar, stem form, shearing, and other features indicated in Plant Schedule or Plant Legend shown on Drawings and complying with ANSI Z60.1; and with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully branched, healthy, vigorous stock, densely foliated when in leaf and free of disease, pests, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement.
1. Trees with damaged, crooked, or multiple leaders; tight vertical branches where bark is squeezed between two branches or between branch and trunk ("included bark"); crossing trunks; cut-off limbs more than 3/4 inch in diameter; or with stem girdling roots will be rejected.
 2. Collected Stock: Do not use plants harvested from the wild, from native stands, from an established landscape planting, or not grown in a nursery unless otherwise indicated.
- B. Grade: Provide trees and shrubs of sizes and grades complying with ANSI Z60.1 for type of trees and shrubs required. Trees and shrubs of a larger size may be used if acceptable to Landscape Architect, with a proportionate increase in size of roots or balls.
1. Contractor is to install all plants shown on the Drawings as specified and in quantities listed on the "Plant Schedule". If any discrepancies arise between the plant schedule and the Drawings, the Drawings shall take precedence.
 2. Plants larger than specified in the plant list may be used if approved by the Project Manager but use of such plants shall not increase the contract price.
 3. Minimum ball size for trees: (These sizes are typical, check with American Standard Nursery Stock for exact specifications or each species).

Tree Size	Ball Depth Minimum	Ball Diameter Minimum
1-1/2" caliper	16"	20"
2" caliper	18"	22"
2-1/2" caliper	20"	24"
3" caliper	22"	28"

- C. Labeling: Label each plant of each variety, size, and caliper with a securely attached, waterproof tag bearing legible designation of common name and full scientific name, including genus and species. Include nomenclature for hybrid, variety, or cultivar, if applicable for the plant as shown on Drawings.
- D. If formal arrangements or consecutive order of plants is shown on Drawings, select stock for uniform height and spread, and number the labels to assure symmetry in planting.
- E. Balled & burlapped plant material shall be dug with firm natural balls or earth of sufficient diameter and depth to include most of the fibrous roots. Tree ball shapes shall be truncated cones. Balled & burlapped plants may be rejected for failure to meet good digging practices. No balled plant shall be placed if the ball is cracked or broken either before or during the planting process. Any plant that is loose in the ball shall be removed from the site & replaced.

- F. Container Grown Stock Requirements:
1. Container grown stock shall have a root system sufficiently developed to hold the container soil together firm & whole. No plants shall be loose in the containers. No plant shall be container-bound.
 2. Use rigid containers that will hold ball shape and protect root mass during shipping of not less than the minimum sizes recommended by ANSI Z60.1.
 3. Where formal arrangements or consecutive order of trees are shown, select stock for uniform height and spread, and label with number to assure symmetry in planting.
- G. Substitutions will not be permitted unless upon evidence that a plant is not obtainable and upon authorization from the Project Manager. The nearest obtainable size and variety of plant material having the same essential characteristics shall be used as a substitute. No adjustments of contract price shall be made by the Contractor.

2.3 SHADE AND FLOWERING TREES

- A. Shade Trees: Single-stem trees with straight trunk, well-balanced crown, and intact leader, of height and caliper indicated, complying with ANSI Z60.1 for type of trees required.
1. Provide balled and burlapped trees.
 2. Branching Height: One-third to one-half of tree height.
 3. Size: Refer to drawings.
 4. Quantity: Refer to drawings.
- B. Small Trees: Branched or pruned naturally according to species and type, with relationship of caliper, height, and branching according to ANSI Z60.1; stem form as follows:
1. Stem Form: Single stem.
 2. Provide balled and burlapped trees.
 3. Size: Refer to drawings.
 4. Quantity: Refer to drawings.
- C. Multistem Trees: Branched or pruned naturally according to species and type, with relationship of caliper, height, and branching according to ANSI Z60.1; stem form as follows:
1. Stem Form: Clump.
 2. Provide balled and burlapped trees.
 3. Size: Refer to drawings.
 4. Quantity: Refer to drawings.

2.4 DECIDUOUS SHRUBS

- A. Form and Size: Deciduous shrubs with not less than the minimum number of canes required by and measured according to ANSI Z60.1 for type, shape, and height of shrub.
1. Provide container-grown shrubs.
 2. Size: Refer to drawings.
 3. Quantity: Refer to drawings.

2.5 BROADLEAF EVERGREENS

- A. Form and Size: Normal-quality, well-balanced, broadleaf evergreens, of type, height, spread, and shape required, complying with ANSI Z60.1.

1. Provide container-grown trees.
2. Size: Refer to drawings.
3. Quantity: Refer to drawings.

2.6 TREE STABILIZATION MATERIALS

A. Root-Ball Stabilization Materials:

1. Proprietary Root-Ball Stabilization Devices: Proprietary at- or below-grade stabilization systems to secure each new planting by root ball; sized per manufacturer's written recommendations unless otherwise indicated.
 - a. Product: Subject to compliance with requirements, provide Platypus Anchors Inc. (USA Office 2008 Garner Station Boulevard, Raleigh, NC 27603, USA; 866-752-8478); Platypus Rootball Fixing System with Plati-mat.

B. Stakes and Guys

1. Upright and Guy Stakes: Rough-sawn, sound, new hardwood, redwood, or current acceptable pressure-preservative-treated softwood, free of knots, holes, cross grain, and other defects, 2 by 2 inches (50 by 50 mm) by length indicated, pointed at one end.
2. Guy and Tie Wire: ASTM A 641/A 641M, Class 1, galvanized-steel wire, 2-strand, twisted, 0.106 inch (2.7 mm) in diameter for large trees, 0.080-inch in diameter for small trees.
3. Guy Cable: 5-strand, 3/16-inch-diameter, galvanized-steel cable, with zinc-coated turnbuckles, a minimum of 3 inches long, with two 3/8-inch galvanized eyebolts.
4. Strap Chafing Guard: 12" – 18" Nylon woven straps with two non corrosive reinforced grommets.
5. Flags: Standard surveyor's plastic flagging tape, white, 6 inches long

2.7 MISCELLANEOUS PRODUCTS

- A. Trunk-Wrap Tape: Two layers of crinkled paper cemented together with bituminous material, 4-inch-wide minimum, with stretch factor of 33 percent applied late November through late April. Re-apply trunk wrap that has loosened or removed due to weather or other circumstances during this period. Remove in late April.
- B. Antidesiccant: Water-insoluble emulsion, permeable moisture retarder, film forming, for trees and shrubs. Deliver in original, sealed, and fully labeled containers and mix according to manufacturer's written instructions.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive plants for compliance with requirements and conditions affecting installation and performance.
 1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
 2. Do not mix or place soils and soil amendments in frozen, wet, or muddy conditions.

3. Suspend soil spreading, grading, and tilling operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
 4. Uniformly moisten excessively dry soil that is not workable and which is too dusty.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Architect and replace with new planting soil.

3.2 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities and turf areas and existing plants from damage caused by planting operations.
1. Protect grade stakes set by others until directed to remove them.
- B. See Division 32 Section "Planting Preparation" for soil preparation, planting soil stabilization, and landscape grading.
- C. Lay out individual tree and shrub locations and areas for multiple plantings as indicated on Drawings. Stake locations, outline areas, adjust locations when requested, and obtain Architect's acceptance of layout before excavating or planting. Make minor adjustments as required.
- D. Apply antidesiccant to trees and shrubs using power spray to provide an adequate film over trunks (before wrapping), branches, stems, twigs, and foliage to protect during digging, handling, and transportation.
1. If deciduous trees or shrubs are moved in full leaf, spray with antidesiccant at nursery before moving and again two weeks after planting.
- E. Wrap trees and shrubs with burlap fabric over trunks, branches, stems, twigs, and foliage to protect from wind and other damage during digging, handling, and transportation.

3.3 EXCAVATION FOR TREES AND SHRUBS

- A. Planting Pits and Trenches: Excavate circular planting pits with sides sloping inward at a 45-degree angle. Excavations with vertical sides are not acceptable. Trim perimeter of bottom leaving center area of bottom raised slightly to support root ball and assist in drainage away from center. Do not further disturb base. Ensure that root ball will sit on undisturbed base soil to prevent settling. Scarify sides of planting pit smeared or smoothed during excavation.
1. Excavate approximately three times as wide as ball diameter for balled and burlapped, balled and potted, or container-grown stock.
 2. Excavate at least 12 inches wider than root spread and deep enough to accommodate vertical roots for bare-root stock.
 3. Do not excavate deeper than depth of the root ball, measured from the root flare to the bottom of the root ball.
 4. If area under the plant was initially dug too deep, add soil to raise it to the correct level and thoroughly tamp the added soil to prevent settling.
 5. Maintain required angles of repose of adjacent materials as shown on the Drawings. Do not excavate subgrades of adjacent paving, structures, hardscapes, or other new or existing improvements.
 6. If drain tile is shown on Drawings or required under planting areas, excavate to

top of porous backfill over tile.

- B. Subsoil removed from excavations should be amended and used as planting soil mix for backfill. A minimum of 1/3 of the excavated subsoil should be discarded and replaced with amended topsoil. Excavated soil and amended topsoil should be thoroughly mixed prior to use as planting soil mix for backfill. Till mixture if clods larger than 2" are present.
- C. Obstructions: Notify Architect if unexpected rock or obstructions detrimental to trees or shrubs are encountered in excavations.
 - 1. Hardpan Layer: Drill 6-inch- diameter holes, 24 inches apart, into free-draining strata or to a depth of 10 feet, whichever is less, and backfill with free-draining material.
- D. Drainage: Notify Architect if subsoil conditions evidence unexpected water seepage or retention in tree or shrub planting pits.
- E. Fill excavations with water and allow to percolate away before positioning trees and shrubs.

3.4 TREE AND SHRUB PLANTING

- A. Before planting, verify that root flare is visible at top of root ball according to ANSI Z60.1. If root flare is not visible, remove soil in a level manner from the root ball to where the top-most root emerges from the trunk. After soil removal to expose the root flare, verify that root ball still meets size requirements.
- B. Remove stem girdling roots and kinked roots. Remove injured roots by cutting cleanly; do not break.
- C. Set balled and burlapped stock plumb and in center of pit or trench with top of root ball 1 inch above adjacent finish grades.
 - 1. Remove burlap and wire baskets from tops of root balls and partially from sides, but do not remove from under root balls. Remove pallets, if any, before setting. Do not use planting stock if root ball is cracked or broken before or during planting operation.
 - 2. Place planting soil mix around root ball in layers, tamping to settle mix and eliminate voids and air pockets. When pit is approximately one-half backfilled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed. Water again after placing and tamping final layer of planting soil mixes.
- D. Set container-grown stock plumb and in center of pit or trench with top of root ball 1 inch above adjacent finish grades.
 - 1. Carefully remove root ball from container without damaging root ball or plant.
 - 2. Place planting soil mix around root ball in layers, tamping to settle mix and eliminate voids and air pockets. When pit is approximately one-half backfilled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed. Water again after placing and tamping final layer of planting soil mixes.
- E. When planting on slopes, set the plant so the root flare on the uphill side is flush with the surrounding soil on the slope; the edge of the root ball on the downhill side will be above the surrounding soil. Apply enough soil to cover the downhill side of the root ball.
- F. Organic Mulching: Apply 3-inch, average thickness of organic mulch extending 12 inches

beyond edge of planting pit or trench. Do not place mulch within 3 inches of trunks or stems.

- G. Wrap trees of 2-inch caliper and larger with trunk-wrap tape. Start at base of trunk and spiral cover trunk to height of first branches. Overlap wrap, exposing half the width, and securely attach without causing girdling. Inspect tree trunks for injury, improper pruning, and insect infestation; take corrective measures required before wrapping. Remove tree wrap when seasonal conditions permit.

3.5 MECHANIZED TREE SPADE PLANTING

- A. Coniferous Trees shall be planted with an approved mechanized tree spade at the designated locations. Do not use tree spade to move trees larger than the maximum size allowed for a similar field-grown, balled-and-burlapped root-ball diameter according to ANSI Z60.1, or larger than the manufacturer's maximum size recommendation for the tree spade being used, whichever is smaller.
- B. When extracting the tree, center the trunk within the tree spade and move tree with a solid ball of earth.
- C. Cut exposed roots cleanly during transplanting operations.
- D. Use the same tree spade to excavate the planting hole as was used to extract and transport the tree.
- E. Plant trees as shown on Drawings, following procedures in "Tree, Shrub, and Vine Planting" Article.
- F. Where possible, orient the tree in the same direction as in its original location.

3.6 TREE AND SHRUB PRUNING

- A. Remove only dead, dying, or broken branches. Do not prune for shape.
- B. Prune, thin, and shape trees and shrubs as directed by Architect.
- C. Prune, thin, and shape trees and shrubs according to standard professional horticultural and arboricultural practices. Unless otherwise indicated by Architect, do not cut tree leaders; remove only injured, dying, or dead branches from trees and shrubs; and prune to retain natural character.
- D. Do not apply pruning paint to wounds.

3.7 TREE STABILIZATION

- A. Root-Ball Stabilization: Install at- or below-grade stabilization system to secure each new planting by the root ball unless otherwise indicated.
 - 1. Proprietary Root-Ball Stabilization Device: Install root-ball stabilization system sized and positioned as recommended by manufacturer unless otherwise indicated and according to manufacturer's written instructions.
- B. Upright Staking and Tying: Stake trees of 2- through 5-inch caliper. Stake trees of less than 2-inch caliper only as required to prevent wind tip-out. Use a minimum of 2 stakes of length required to penetrate at least 18 inches below bottom of backfilled excavation and to extend at least 72 inches above grade. Set vertical stakes and space to avoid penetrating root balls or root masses. Support trees with two strands of tie wire encased in hose sections at contact points with tree trunk. Allow enough slack to avoid rigid

restraint of tree. Use the number of stakes as follows:

1. Use 2 stakes for trees up to 12 feet high and 2-1/2 inches or less in caliper; 3 stakes for trees less than 14 feet high and up to 4 inches in caliper. Space stakes equally around trees.
2. Remove all tree stakes and guy wire at the end of the warranty period.

3.8 TREE PROTECTION DEVICES

- A. Install deer protection cages to the height of the lowest branches. Cage should be constructed so that it can be temporarily removed and reinstalled when necessary.

3.9 CLEANUP AND PROTECTION

- A. During planting, keep adjacent paving and construction clean and work area in an orderly condition.
- B. Protect plants from damage due to landscape operations and operations of other contractors and trades. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged plantings.
- C. After installation and before Substantial Completion, remove nursery tags, nursery stakes, tie tape, labels, wire, burlap, and other debris from plant material, planting areas, and Project site.

3.10 DISPOSAL

- A. Remove surplus soil and waste material including excess subsoil, unsuitable soil, trash, and debris and legally dispose of them off Owner's property.

END OF SECTION

SECTION 32 94 13**ALUMINUM LANDSCAPE EDGING****PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes aluminum landscape edgings as mulch edge restraints.
- B. Related Sections:
 - 1. Division 31 Section "Earth Moving" for excavation, filling, and rough grading and for subsurface aggregate drainage and drainage backfill materials.
 - 2. Division 32 Section "Prairie Grasses and Wildflowers" for meadow planting, hydromulching, and erosion-control materials.

1.3 DEFINITIONS

- A. Finish Grade: Elevation of finished surface of planting soil.
- B. Planting Area: Areas to be planted.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. LEED Submittals:
 - 1. Product Data for Credit MR 4.1 and Credit MR 4.2 – Recycled Content: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
 - a. Include statement indicating costs for each product having recycled content.
- C. Samples for Verification: For each of the following:
 - 1. Edging Materials and Accessories: Manufacturer's standard size, to verify color selected.
- D. Qualification Data: For qualified landscape Installer. Include list of similar projects completed by Installer demonstrating Installer's capabilities and experience. Include project names, addresses, and year completed, and include names and addresses of owners' contact persons.
- E. Warranty: Sample of special warranty.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified landscape Installer whose work has resulted in successful installation of edgings similar to those indicated for the Project.

- B. Preinstallation Conference: Conduct conference at Project site.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Packaged Materials: Deliver packaged materials in original, unopened packages, name and address of manufacturer.

1.7 PROJECT CONDITIONS

- A. Field Measurements: Verify actual grade elevations, service and utility locations, irrigation system components, and dimensions of plantings and construction contiguous with new plantings by field measurements before proceeding with edging work.
- B. Coordination with Turf Areas (Lawns): Install edgings after finish grades are established and before planting turf areas unless otherwise indicated.
 - 1. When planting trees, shrubs, other plants, and mulch after installing edgings, protect edgings, and promptly repair damage caused by planting operations.

1.8 WARRANTY

- A. Special Warranty: Installer agrees to repair or replace edgings that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Faulty performance of edgings.
 - b. Deterioration of metals and metal finishes beyond normal weathering.
 - 2. Warranty Periods from Date of Substantial Completion: 12 months:

PART 2 - PRODUCTS

2.1 LANDSCAPE EDGINGS

- A. Recycled Content of Aluminum Products: Provide products with an average recycled content of aluminum so postconsumer recycled content plus one-half of preconsumer recycled content is not less than 100 percent.
- B. Aluminum Edging: Standard-profile extruded-aluminum edging, ASTM B 221, Alloy 6063-T6, fabricated in standard lengths with interlocking sections with loops stamped from face of sections to receive stakes. Edging to have roll-top or rounded-mill top to provide "non-sharp" exposed edge.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Permaloc Corporation; CleanLine XL or comparable product by one of the following:
 - a. Curv-Rite, Inc.
 - b. Russell, J. D. Company (The).
 - c. Sure-Loc Edging Corporation.
 - 2. Edging Size: 3/16 inch wide by nominal 6 inches deep.
 - 3. Stakes: Aluminum, ASTM B 221, Alloy 6061-T6, approximately 1-1/2 inches wide by minimum 12 inches long.
 - 4. Finish: Mill Finish (Silver).

PART 3 - EXECUTION**3.1 EXAMINATION**

- A. Examine areas to receive edging for compliance with requirements and conditions affecting installation and performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities and turf areas and existing plants from damage caused by edging operations.

3.3 EDGING INSTALLATION

- A. Aluminum Edging: Install aluminum edging where indicated according to manufacturer's written instructions. Anchor with aluminum stakes spaced as recommended by manufacturer but not more than 36 inches apart, driven below top elevation of edging.

3.4 CLEANUP AND PROTECTION

- A. During edging operations, keep adjacent paving and construction clean and work area in an orderly condition.
- B. Protect edging from damage due to landscape operations and operations of other contractors and trades. Maintain protection during installation and maintenance periods. Repair or replace damaged edgings.
- C. Construction Waste Management And Disposal: Comply with Waste Management Plan required under Division 01 Section "Construction Waste Management And Disposal."

END OF SECTION

SECTION 33 01 00**OPERATION AND MAINTENANCE OF UTILITIES****PART I - GENERAL****1.1 SUMMARY**

- A. Description
 - 1. This work consists of maintenance and support of existing utilities during construction.
 - 2. All existing utilities shall be maintained and adequately supported until the proposed utility relocations are completed.

PART II – PRODUCTS - NOT USED**PART III - EXECUTION****3.1 GENERAL**

- A. The Contract Drawings show the utilities as they existed at the drawing date based on the best available information. All utility work for the Project that is performed in this Contract and by the utility owners is shown on these Contract Drawings.
- B. Existing facilities to be abandoned will be in service until the Contractor or utility owner has completed all connections to the new, relocated facility. Any utility that is in service, whether temporarily or permanently must be protected from damage. If a facility that is planned to be abandoned is damaged before it can be permanently removed from service, the Contractor shall make, or pay the utility owner to make, any repairs necessary to maintain the facility, just as if the facility is indicated to permanently remain in service.
- C. Contractor shall contact the utility owner to determine the current service status of any proposed facility or any existing facility to be abandoned.
- D. The Contractor shall arrange with the owners and operators of the respective utility systems to mark the location and, if necessary or prudent, to expose the existing utilities prior to construction of the facilities included in this Contract.
- E. Except for facilities to be relocated by the utility owners as part of this Project, and abandoned facilities indicated to be removed under this contract, the existing utilities within the work area, including but not limited to, power transmission and distribution systems, street lighting, fiber optic, telephone, and traffic signals, whether shown on the Plans or not, shall not be disturbed.
- F. If major utilities, such as sewer, water, gas, electric power and telephone, not shown on the Plans are encountered while excavating, the Contractor shall stop excavation, and immediately advise KCMO and the affected utility.
- G. Minor underground utility service lines, such as, sanitary sewer, gas and water services, side sewers, house or yard drains, electric lighting, or telephone services, shall be

maintained, relocated, rerouted, removed, and restored by the Contractor, during the execution of the work and for Contractor's convenience, with the least possible interference with such services.

3.2 NOTIFICATION OF UTILITIES AND AGENCIES

- A. The Contractor shall obtain prior approval from the cities for closing or partial closing of any street. Give at least two (2) working days advance notice of such closure to all agencies providing emergency services, including without limitation police, fire and ambulance services. Notification shall include but not be limited to, local jurisdiction, owner of the road, street, lane, etc. Notification shall include, but not be limited to the time of commencement and completion of work, names of streets or location of alleys to be closed, or partially closed, schedule of operations and routes of detours where applicable.
- B. It shall be prima facie notification if a valve box or utility meter is visible under ordinary conditions, marked by a stake or a reference stake or is pointed out to the Contractor or his representative. The staking and pointing out by an employee of the utility will have the same force as if it were done by the Engineer. Under these conditions, the Contractor will be fully responsible for damage to these items.
- C. When performing work in streets and easements, whether inside or outside the Project limits, notify all of the affected utilities and local agencies about the operations so as to properly coordinate and expedite the work in such a manner as to cause the least amount of conflict and interference between the work and operations of other agencies. Where service to customers of the utility may occur, notify affected customers at least 24 hours in advance. For interruptions which are not restored on the same day a plan shall be approved with the affected utilities and customers to either provide temporary service or interrupt the service.
- D. Existing utilities as shown on the utility drawings are compiled based on the utility as-built drawings and field locate survey available to the Utility Consultant. As such the existing utilities may not be located as indicated on the Plans. Existing utility locations shall be field verified by the Contractor. Request on-site utility locations from One-Call Location Service and utility owners by phone and confirm by letter 48 hours prior to working in areas requiring on-site location of utilities during progress of the work. Notify the utility owners and the locator service agencies by phone at least 48 hours prior to excavation.
- E. There will be other utilities and/or companies with private facilities located in the working area. Notify them, if possible.
- F. For construction work, KCMO shall relocate or cause to be relocated all privately or publicly owned utility conduits, lines, poles, mains, pipes and such other facilities within their jurisdiction and control where such relocation is necessary in order to conform said utility and other facilities to the Plans and ultimate requirements of the Project. Contractor shall call the above listed locator service and the utilities for location of their facilities prior to excavation.
- G. The right is reserved by the KCMO and the owners of utilities, or their authorized agents, to enter upon the right-of-way for the purpose of making changes as are necessary for the rearrangement of their facilities or for making necessary connections or repairs. The Contractor shall cooperate with forces engaged in this work and shall conduct his operations in such a manner to avoid any unnecessary delay or hindrance to the work being performed by other forces.

3.3 UTILITIES AND EXISTING IMPROVEMENTS

- A. Operation of water valves and hydrants by unauthorized personnel is strictly prohibited. Obtain hydrant permits and/or written permission from the governing agency and pay any required fees, prior to using water hydrant.
- B. Provide for the flow of sewers, drains, or water courses interrupted during the progress of the work, and restore such drains or water courses.
- C. Repair any and all damage to any utility as may be caused by the work. Maintain in place utilities, not shown on the drawings, to be relocated or altered by others. Maintain utilities which are relocated by others in their relocated positions in order to avoid interference with structures which cross the Contract work.
- D. Make exploratory excavations and borings ahead of work, as necessary, to determine the exact location of interfering utilities or underground structures. When this potholing is not feasible or practical or the need for such work was not foreseen, such utility owners or the owner shall have the right to enter upon the right-of-way and upon any structure therein for the purpose of making new installations, changes or repairs.

3.4 LIGHTING AND ELECTRICAL

- A. Contractor shall make all arrangements and pay all costs associated with the connection for any temporary lighting systems to KCPL (Kansas City Power & Light). Contractor shall obtain certification of the electrical lighting system from KCPL.

PART 4 – MEASUREMENT

Not Used

PART 5 - PAYMENT**PAYMENT**

No separate payment will be made for this item, unless specifically listed in the Bid Form-Unit Prices. All costs pertaining thereto shall be included in the Contract Unit Price(s) for other items.

END OF SECTION

SECTION 33 05 13.13**ADJUSTMENT OF INCIDENTAL STRUCTURES****PART I – GENERAL****1.1 SUMMARY**

A. Description:

1. The work in this Section covers the adjustment to required grade of the tops of existing structures, including but not limited to manholes, catch basins, sumps, inlets, valve boxes, meter boxes, and monument boxes, which may be disturbed during construction, and similar structures as shown on the Contract Drawings, as specified herein.

1.2 REFERENCES

<u>Sponsor</u>	<u>Number</u>	<u>Subject</u>
APWA	33 05 14	Utility Grade Adjustment
AASHTO	M 105	Grey Iron Casting

1.3 DEFINITIONS

- A. Manholes refer to structures designed to permit human entry and working space inside and to confine and control the flow of pipe-conveyed liquids. These structures are collectively referred to as manholes regardless of composition, design, type or depth.
- B. Box refers to valve boxes, meter boxes, monument boxes, fire hydrants, electrical pull box or other like structures not intended for human entry, which need to be adjusted due to a slope or grade change.
- C. Vault refers to structures intended for human entry containing electrical/ telephone facilities or other like structures, which need to be adjusted due to a grade change.

PART II – PRODUCTS**2.1 GENERAL**

Materials to be used in the adjustment of incidental structures shall be either materials salvaged from the existing installation and brought to a condition suitable for reuse, or new materials conforming to the requirements of other applicable Sections of these specifications.

PART III – EXECUTION**3.1 CONSTRUCTION**

- A. Adjustment of incidental structures shall include, but is not limited to, the adjustment to grade, relocation or removal and reinstallation of the following items as required:

1. Manhole Frames and Covers
 2. Inlet Frames and Grates
 3. Valve Box Frames, Covers and Traffic Rated Lids
 4. Meter Box Frames, Steel Covers
 5. Monument Box Frames and Covers
 6. Clean-Out Frames and Covers
 7. Vault Frames and Covers
 8. Water Line and Valves
 9. Fire Hydrants
 10. Private Utility Structures -such as gas, telephone, electrical, cable television, will be relocated by the owners of those facilities.
- B. Metal frames, covers, grates and fittings may be salvaged from structures to be adjusted, and if of suitable size and condition may be reused in the work. Any parts that are damaged or are unfit for reuse, shall be replaced with similar items comparable in all respects with those they are to replace and which are adequate for the intended purpose. Construction shall be in accordance with the provisions of the appropriate Sections of these Specifications.
- C. Base drains at inlets, gravel backfill at sumps and all stone bases disturbed by or fouled because of the adjusting work shall be repaired, replaced or restored to the condition at the time work commenced.
- D. Any aggregate bases, treated bases, or pavements disturbed by adjustment shall be repaired.
- E. The adjusted structures shall be adequate in all respects for the service rendered by them prior to being adjusted.
- F. Metal inlets, valve boxes, meter boxes, monument boxes and other like structures shall be raised or lowered to grade normally by resetting the entire structure on firm foundation or, in the case of raising the structure, to a point where it would enclose or protect its contents, by adding concrete extensions of like design below the original structure or by complete replacement of the structure with a new structure of adequate design. Construction shall be in accordance with the provisions of the appropriate Sections of these Specifications.
- G. Salvaged structures not reused or provided to the utility company or KCMO as required, shall become the property of the Contractor.
- H. Fire hydrant relocation shall be performed by the Contractor as required by the local jurisdiction. Where these requirements differ, those of the local jurisdiction shall govern.
- I. Raising Tops of Masonry Structures
1. After existing frames, covers and grates have been removed, the exposed top surface on which new mortar or concrete is to be placed shall be chipped away to a depth of at least 1/4 inch to expose firm concrete and the new surface shall be cleaned by brushing and shall be moistened with water at the time of placing new concrete thereon. New concrete shall then be placed to required grade and cured at least three days, after which the frame shall be seated in fresh mortar and brought to proper grade. Masonry of bricks or concrete blocks shall be raised with new bricks, blocks, mortar or combinations thereof or with Portland cement concrete, as conditions may require or permit. Concrete boxes may be lifted and placed on

precast concrete box extensions, or new brick or on cast-in-place concrete as may be suitable.

2. Mortar for building up existing masonry shall be placed to a depth of not more than two inches. Concrete shall be placed to a depth of not less than 3 ½ inches. To conform to these requirements, existing shells or walls of structures to be raised shall be cut down as necessary to provide space for the new construction. Rebar used in adjusting to grade shall conform to Section 03 20 00 and as shown on the contract drawings.

J. Lowering Tops of Masonry Structures:

1. Where the top of an existing masonry structure is to be lowered, the masonry portion of the structure shall be exposed to required depth, cut off or removed to an elevation below that established for the bottom of metal frame or cover which is to be reset on masonry and shall then be built up with mortar, concrete, brick or concrete blocks, to the required elevation and top design. When joining new material to old, minimum thicknesses of new mortar and concrete, limitations, curing and other details shall be as set forth above.

K. Adjust Structures to Grade:

1. Manholes, inlets, catch basins and similar structures shall be brought to the specified finished grade by methods of construction as required in the APWA Standard Specifications, Section 33 05 14.
2. Excavation necessary for bringing structures to grade shall center about the structure and be held to the minimum area as approved. At the completion of the structure adjustment, the void around the structure shall be backfilled with crushed aggregate and thoroughly compacted before paving. A concrete collar shall be placed around each lid and frame.
3. When adjustment of the top of existing manholes to a lower grade is approved by the Engineer, the following requirements will prevail:
 - a. The manhole cone shall not be reduced to a point such that the inside diameter will be less than 25-3/4 inches.
 - b. The manhole frame casting shall not rest on the manhole step.
 - c. A 12-inch wide, 3000 psi or greater concrete collar will be constructed around the frame casting from below the top of cone and flush with the top of manhole frame casting. Collar shall be a minimum of 8 inches thick and be circular in shape. For manholes located within concrete pavement areas, provide blockouts a minimum of 1 foot outside of edge of ring. Set lids below adjacent pavement section as follows: ¼ inch in concrete pavement; ½ inch in asphalt pavement and 1 inch in landscaped areas.
 - d. If the cone is cracked during construction, the manhole will be restacked with shorter manhole sections and a new cone shall be installed.

PART IV – MEASUREMENT

Not Used

PART V - PAYMENT

PAYMENT

No separate payment will be made for this item, unless specifically listed in the Bid Form-Unit Prices.
All costs pertaining thereto shall be included in the Contract Unit Price(s) for other items.

END OF SECTION

SECTION 33 05 16**UTILITY ADJUSTMENTS****PART 1 – GENERAL****A. ADJUSTMENTS**

1. Items under this heading include utility adjustments in conjunction with the scope of work for this project as follows: water mains, water service lines, sewer service lines, gas service lines and buried and or overhead cables, utility poles, traffic signals, signal poles and signal cables belonging to public utility companies or the private consumers, such as the KCMO Water Services Department, KCMO Streets & Traffic Division, Gas Service, electric, cable TV, telephone, and other non-franchise utility companies, damaged during the construction of this project shall be repaired as necessary in conformance with the regulations of the involved utilities.
2. The CONTRACTOR is responsible for the maintenance of service of all sewer mains and building sewers encountered during construction. The CONTRACTOR shall not be entitled to additional compensation for the repair of any such lines damaged during his operations.
3. Gas Valve Box Adjustments. Missouri Gas Energy (MGE) shall be notified of broken boxes or missing lids; MGE will repair and adjust the box or provide new lids to the CONTRACTOR. The CONTRACTOR shall notify the appropriate MGE District Supervisor at least two (2) days in advance, of any tear-out location which involves a gas valve cover within a concrete area. This notification shall include the specific location and the date of the scheduled tear-out. The CONTRACTOR shall not place new concrete or asphalt over a gas valve cover.

B. RELOCATIONS

1. Relocations or adjustments to facilities owned by Utility Companies will be accomplished by the utility company at no cost to the CONTRACTOR except Water, City owned Street Lights, and sanitary sewer lines which will be covered by a separate Contract.
2. The OWNER will endeavor to have all necessary adjustments or relocations of public or private utility facilities in direct conflict with the roadway work made as soon as practicable. Such adjustments or relocations will be made at no cost to the CONTRACTOR. The adjustments or relocations may be completed before the CONTRACTOR progresses to the points affected. Under some circumstances, however, such adjustments or relocations may have to be performed during the CONTRACTOR'S construction. The CONTRACTOR shall be responsible for coordinating his work with that of the utility owners or their CONTRACTORS so as to cause the least possible delay in the work.

3. Locations or grades of items shown on the Plans are considered approximate only. No guarantee is made as to the accuracy or completeness thereof.
4. It is anticipated that unknown items not shown on the plans will also be uncovered during excavations and shall require adjustment as specified herein. The CONTRACTOR shall carefully note the location of all such items exposed and report the information to the Utility. The CONTRACTOR'S employees shall not knowingly cover over permanently any such items unless specifically instructed to do so.

C. STREET RIGHT-OF-WAYS/EASEMENTS

Utilities located in street right-of-way; except water, sanitary sewer, and street lighting; requiring adjustment or relocation for this construction shall be adjusted or relocated by the respective owner at no cost to the CONTRACTOR. The CONTRACTOR shall be responsible for coordinating this activity with the responsible utility.

D. PROTECTION

Utilities located in utility easements or private easements shall be protected. The CONTRACTOR may incur some expense when enlisting the assistance of the utility owner for such protection.

PART 2 – PRODUCTS

None

PART 3 – EXECUTION

None

PART 4 – MEASUREMENT

Not Used

PART 5 - PAYMENT

PAYMENT

No separate payment will be made for this item, unless specifically listed in the Bid Form-Unit Prices. All costs pertaining thereto shall be included in the Contract Unit Price(s) for other items.

END OF SECTION

SECTION 33 11 13.13**DUCTILE IRON PIPE FOR WATER MAINS**

PART 1 - GENERAL

1.01 SECTION DESCRIPTION

- A. This section provides for pipe, fittings, and appurtenances associated with the installation of ductile iron pipe water main. This section applies to all water main 16" diameter and smaller and to other sizes when ductile iron pipe is selected. Installation of all other ductile iron pipe shall be in accordance with Kansas City, Missouri Water Services Department, Rules and Regulations for Water Main Extensions and Relocations.

Pipe shall be tested in accordance with Section 33 13 00 – Watermain Testing, Disinfection and Dechlorination.

1.02 SECTION INCLUDES

- a. Pipe
- b. Fittings
- d. Appurtenances
- d. Shop Coating and Lining
- e. Bolts and Nuts
- f. Protective Coatings

1.03 REFERENCES

- A. The following standards are referenced directly in this section. The latest version of these standards shall be used.

ANSI/NSF61 – Drinking Water Treatment Chemicals

ASTM A53 – Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated, Welded and Seamless

ASTM A307 – Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile

ASTM D4976 – Standard Specification for Polyethylene Tubing

AWWA C104/ANSI A21.4 – Cement-Mortar Lining for Cast-Iron Pipe and Fittings

AWWA C105/ANSI A21.5 – Polyethylene Encasement For Ductile Iron Piping.

AWWA C110/ANSI A21.10 – Gray-Iron and Ductile Iron Fittings

AWWA C111/ANSI A21.11 – Rubber-Gasket Joints for Cast Iron and Ductile Iron Pressure Pipe and Fittings

AWWA C115/ANSI A21.15 – Flanged Ductile-Iron Pipe with Ductile Iron or Gray Iron Thread

AWWA C150/ANSI A21.50 – Standard for the Thickness Design of Ductile Iron Pipe

AWWA C151/ANSI A21.51 – Ductile Iron Pipe Centrifugally Cast for Water

AWWA C153/ANSI A21.53 – Ductile-Iron Compact Fittings, 3 in. through 24 in

AWWA C203 – Standards for Steel Pipe

AWWA C550 – Protective Epoxy Interior Coatings for Valves and Hydrants

AWWA C600 – Installation of Ductile Iron Water Mains and their Appurtenances

PART 2 - PRODUCTS

2.01 WATER MAIN PIPE MATERIALS.

A. Pipe

1. Unless indicated otherwise, all 4" diameter through 12" diameter shall be thickness class 52. Pipe 16-inch diameter and larger shall be thickness Class 54 minimum. The pipe shall be designed in accordance with AWWA C150-ANSI A21.50 and manufactured per AWWA C151-ANSI A21.51 complete with all accessories.
2. All ductile iron pipe, and all fittings, valves, and other buried appurtenances, shall be encased in polyethylene.
3. Joints: The joints shall be of the push-on type unless otherwise specified conforming to ANSI/AWWA C111/A21.11, except gaskets shall be neoprene or synthetic rubber. Gaskets shall be certified as suitable for chlorinated potable water in accordance with ANSI/NSF61. Natural rubber will not be acceptable.
4. Restrained Joints: See Section 02669 of the Standards and Specifications for Water Main Extensions and Relocations.

B. Fittings

1. All fittings shall be made of Ductile Iron and manufactured according to AWWA C110/ANSI A21.10 or AWWA C153/ANSI A21.53.
2. Fitting joints shall be Mechanical Joint (MJ), Flange Joint (FLG), or Push-On Joint, per AWWA C111/ANSI A21.11. All MJ glands shall be ductile iron. Fittings shall have distinctly cast upon them, the pressure rating and the letters "DI" or "Ductile." FLG Fittings shall be used only for aboveground installations.
3. Flanged Joints: Shall be provided with full-face gaskets and shall meet the requirements of AWWA C115/ANSI A21.15.

C. Appurtenances

1. Welded - On Outlets: May not be used in lieu of tees.
2. Tapping Sleeves:
 - a. Material: All material in the body, lugs, outlet, flange, bridge plate, bolts, nuts and washers shall be ASTM A-276 Type 304 or Type 316 or ASTM A-564 Type 630 stainless steel.
 - b. Body: Shall be a minimum of 14 gauge stainless steel and shall fit cast iron pipe classes A, B, C, and D.
 - c. Outlet: Shall be a minimum of 14-gauge stainless steel. The branch outlet shall be supplied with a tap and plug to permit pressure testing the sleeve prior to tapping the main.
 - d. Flange: Shall conform to AWWA C207 Class D with drilling in accordance with ANSI B 16.1 class 125, and shall be indexed per MSS-SP 60 to accept tapping valve.
 - e. Welding: All welding on the coupling shall be done with stainless steel rods.
 - f. Gaskets: Sleeve gaskets shall be full circumferential a minimum of ¼" thick gridded with tapered lap joint ends and stainless steel bridge plates molded flush into the gasket.
 - g. The Outlet: The outlet flange face shall be supplied with a bonded, full-face gasket. All gaskets shall be grade 30 specially compounded rubber, synthetic rubber, or 100 percent neoprene that shall have the necessary qualities to allow outside storage, permanence, and resistance to set after installation.
 - h. Bolts and Nuts: All bolts, nuts and washers shall be loose; lifter bar style bolt attachments shall not be permitted. All bolts and/or nuts shall be impregnated or coated to prevent seizure. Minimum diameter shall be 5/8."

- i. Working Pressure: Sleeve shall be designed for a minimum working pressure of 175 psi.
 - j. General: Power Seal Model 3490-AS; JMC 432; Cascade CST-Ex stainless steel extra heavy duty; Ford Model FTSS; Romac STD Band SST-III; Smith Blair Type 665.
 - k. Power Seal Model 3490MJ or approved equal may also be used.
3. Tie Rods: ASTM A276, Type 304 or Type 316 Stainless Steel.
 4. Couplings: Dresser "Style 38" or Smith-Blair "441 or 411 Flexible Coupling"; without pipe stop. Bolted compression type couplings shall be manufactured of steel or ductile iron specifically for use with ductile iron pipe.

D. Shop Coating and Lining

1. All pipe and fittings shall be cement mortar lined in accordance with AWWA C104/ANSI A21.4. All buried pipe and fittings shall be coated with a black asphaltic coating minimum 1 mil in thickness per AWWA C151/ANSI A21.51. Any pipe or fittings above ground shall be prime coated with 6 mils DFT of Tnemec 140-1211 Epoxy Primer.
2. As an alternative to cement mortar lining on fittings, the manufacturer may use a Fusion Bonded Epoxy on both the interior and exterior that complies with AWWA C550 and is NSF 61 approved for potable water.
3. Ductile Iron Pipe used for sewers shall have an interior protective coating of calcium aluminate mortar (Sewper Coat, as manufactured by Griffin, or approved equal) or an approved PVC lining.

E. Bolts and Nuts

1. Bolts: ASTM A307, chamfered or rounded ends projecting 1/4 to 1/2 inch from surface.
2. Nuts: ASTM A307, hexagonal, ANSI B18.2.2.

F. Marking

1. Markings shall be legibly indented in the pipe or painted thereon with waterproof paint.

2.02 PROTECTIVE COATINGS.

A. Polyethylene Encasement

1. Polyethylene encasement materials shall be in accordance with ASTM D4976 and AWWA C105/ A21.5; LLD-8 mil or HDCL-4 mil.

Item	LLD-8 mil	HDCL-4 mil
Tensile Strength, psi	3,600	6,300
Elongation, percent	800	100
Dielectric Strength, v/mil	800	800
Tear Resistance, gf	2,550	250
Impact Resistance, g	600	800

2. The minimum tube size for each pipe diameter shall be in accordance with AWWA C105 as follows:

Polyethylene Flat Tube Width (inches)

Nominal Pipe Diameter (inches)	Push-on Bell & Spigot Joints	Mechanical Joints
4	14	16
6	17	20
8	21	24
10	25	27
12	29	30
14	33	34
16	37	37
18	41	41
20	45	45
24	53	53

3. Adhesive tape shall be a general purpose adhesive tape 1-inch wide and approximately 8 mils thick, such as Scotch Tape No. 50, Polyken No. 900, Tapecoat CT or approved equal (Duct Tape will not be allowed).
- B. Exterior Surfaces Underground (Excluding Pipe & Fittings): All metal surfaces, including each mechanical coupling, shall be thoroughly cleaned and then coated with Tnemec coal-tar epoxy "High-Build Tnemec-Tar." All material and the application thereof shall conform to AWWA C203.
- C. Above ground pipe and fittings shall be field coated with Tnemec Coal Tar Epoxy "High- Build Tnemec-Tar."

PART 3 - EXECUTION

3.01 HANDLING

- A. Pipe, fittings, and accessories shall be handled in a manner that will ensure installation in a sound, undamaged condition. Equipment, tools, and methods used in unloading, reloading, hauling, and laying pipe and fittings shall be such that the pipe, pipe coating, and fittings are not damaged. Hooks shall not be used. Under no circumstances shall pipe or accessories be dropped or dumped. Pipe and fittings shall not be moved by inserting anything into pipe ends.

Pipe and fittings on which the cement lining has been broken or loosened shall be replaced. Where the damaged areas are small and readily accessible, the lining may be permitted to be repaired in accordance with AWWA C104.

3.02 INSPECTION

- A. Pipe and fittings shall be carefully examined for cracks and other defects immediately before installation. Spigot ends shall be examined with particular care since they are vulnerable to damage from handling. All defective, damaged, or unsound pipe and fittings shall be rejected and marked as such and removed from the site of the work.

3.03 PREPARATION

A. Cutting Pipe

1. Ductile iron pipe shall be cut with a saw or an abrasive wheel. Existing cast iron pipe shall be cut with a saw or abrasive wheel.
2. The cutting of pipe with a torch will not be permitted.
3. Cutting shall be done in a neat manner without damage to the pipe or the cement lining. Cuts shall be smooth, straight, and at right angles to the pipe axis. After cutting, the end of the pipe shall be dressed with a file to remove all roughness and sharp corners.

B. Cleaning

1. The interior of all pipe and fittings shall be thoroughly cleaned of foreign matter before being installed and shall be kept clean until the work has been accepted.
2. Surfaces shall be wire brushed, if necessary, wiped clean, and kept clean until jointing is completed.

3.04 INSTALLATION

A. General

1. Alignment: Runs intended to be straight shall be laid straight. Deflections from a straight line or grade shall not exceed the quantities stipulated in Table 4 or Table 5 of AWWA C600. Shorter pipe sections or special bends shall be installed where the alignment or grade requires them.
2. Laying Pipe: Pipe shall be protected from lateral displacement by pipe embedment material installed as specified in Section 32 11 00. Under no circumstances shall the pipe be laid in water; and no pipe shall be laid in unsuitable trench conditions.
3. Pipe shall be laid with the bell ends facing the direction of laying except when reverse laying is specifically authorized by the WSD.

4. Whenever pipe laying is stopped, the open end of the line shall be sealed with a watertight plug that will prevent water and objects from entering the pipe.
5. No pipe length less than 18" shall be used.

B. Mechanical Joints:

1. The gasket and gland shall, after proper joint cleaning, be in position on the spigot before shoving the pipe to its final position. Center the entering spigot so that the gland or follower ring is parallel to the face of the connecting bell. Joint shall be shoved "home" and the gland properly positioned with respect to the connecting bell with the connecting pipes in as nearly perfect alignment as practicable. The bolts shall be slightly and uniformly tightened. Deflection may be made after the bolts are tightened.
2. Coat the gasket with a lubricant (suitable for potable water) supplied by the pipe manufacturer and all surfaces of the bell, spigot, and gland that will come in contact with the gasket at any time during assembly.
3. Gasket shall be carefully pushed into position and evenly seated in the bell. The gland shall be shoved into place against the gasket, the bolts inserted, and the nuts tightened with the fingers until snug. Final tightening of the bolts shall be done with a ratchet torque wrench.
4. Partially tighten the bottom bolt, then the top bolts, alternately either side, and finally the remaining bolts, alternately tightening bolts 180 degrees apart. This cycle is then to be repeated until all bolts are tightened to the torque specified by the manufacturer:
 - a. 5/8" bolts --- 40 to 60 foot pounds
 - b. 3/4" bolts --- 60 to 90 foot pounds
5. If sealing is not maintained at the torque specified, the joint shall be disassembled, thoroughly cleaned, and reassembled. Overstressing of bolts to compensate for poor installation practice will not be permitted.

C. Push-On Joints:

1. Wipe the gasket seat clean with a cloth and position in place. Coat the gasket with a lubricant supplied by the pipe manufacturer. Apply to all of the inner surface of the gasket that will come into contact with the entering pipe.
2. Clean the plain end of the pipe and apply a thin film of lubricant (suitable for potable water) to the outside of the plain end of the pipe and its beveled edge. Align the plain end of the pipe with the bell of the pipe to which it is to be joined. The joint deflection angle should not exceed the recommended maximum of the manufacturer.

3. Bring the plain end of the pipe in contact with the gasket and exert sufficient force on the entering pipe so that its plain end compresses the gasket and makes contact with the base of the socket of the bell. This force can be applied by means of a jack type tool, backhoe, or other methods approved by the WSD.

D. Flanged Joints:

1. When bolting, care shall be taken to provide uniform gasket compression and prevent unnecessary stress on the flanges. Flange shall be free to move in any direction while the flange bolts are being tightened. Bolts shall be tightened gradually and at a uniform rate to provide uniform gasket compression.
2. Use full-face gaskets only.

E. Restrained Joints:

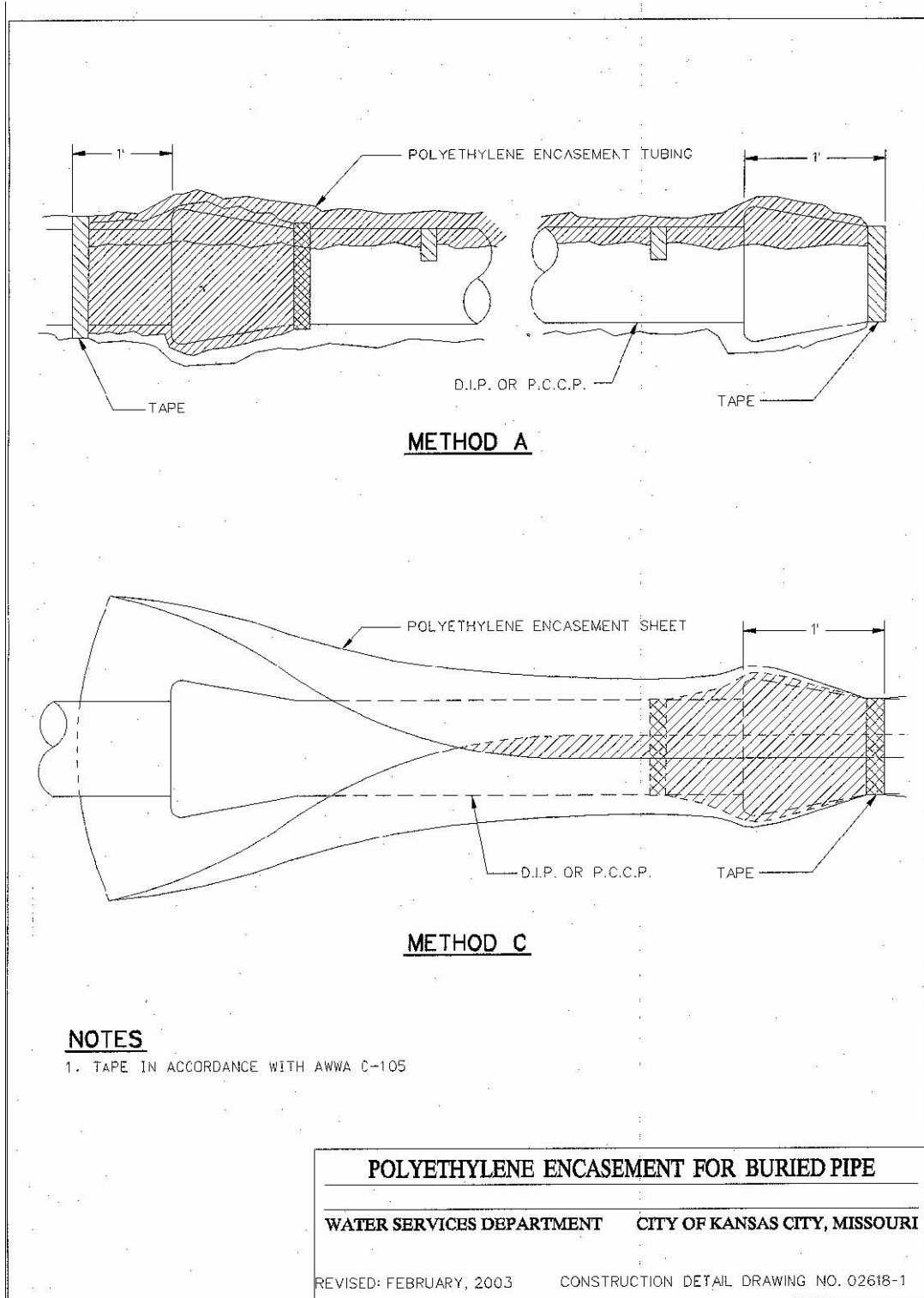
1. Restrained joints shall be installed in accordance with the pipe manufacturer's recommendations.
2. All joints within utility casings shall be restrained joints.

F. Encasement:

1. Polyethylene encasement shall be installed on all ductile iron pipe and fittings. The polyethylene shall prevent contact between the pipe, fittings, and the surrounding embedment.
2. The polyethylene encasement shall be installed as specified in "Method A" or "Method C" below and as shown on the Construction Detail Drawing No. 02618-1.
 - a. Method A: Polyethylene tubing shall be approximately two (2) feet longer than the length of the pipe section to provide a one (1) foot overlap on each adjacent pipe section. Tube ends need not be taped in place unless directed by the WSD. Repair rips, punctures, or other damages to the polyethylene with adhesive tape or with a short length of polyethylene tube cut open, wrapped around the pipe, and secured with adhesive tape as directed by the WSD (duct tape is not allowed).
 - b. Method C: Each section is completely wrapped with a flat polyethylene sheet. The sheets shall be approximately 2 feet longer than the length of the pipe section to provide a one-foot overlap on each adjacent pipe section. Apply adhesive tape as directed by the WSD (duct tape is not allowed).
3. Pipe-Shaped Appurtenances: Bends, reducers, offsets, and other pipe-shaped appurtenances shall be covered with polyethylene in the same manner as the pipe.
4. Odd-Shaped Appurtenances: Valves, tees, crosses, and other odd-shaped pieces that cannot practically be wrapped in a tube shall be wrapped with a flat sheet or split length of polyethylene tube. The sheet shall be passed under the

appurtenance and brought up around the body. Seams shall be made by bringing the edges together, folding over twice, and taping down. Tape polyethylene securely in place at overlaps, valve tops and all other penetrations.

5. Lifting devices shall not be placed over polyethylene.
6. Polyethylene shall be protected from exposure to weather or damage at all times.
7. Openings in Encasement: Openings for branches, service taps, blow-offs, air valves, and similar appurtenances shall be made by making an x-shaped cut in the polyethylene and temporarily folding the film back. After the appurtenance is installed, tape the slack securely to the appurtenance and repair the cut as well as any other damaged areas in the polyethylene with tape. The new appurtenance shall be wrapped.
8. Junctions Between Wrapped and Unwrapped Pipe: Where polyethylene wrapped pipe joins an existing pipe which is not wrapped, extend the polyethylene tube to cover the unwrapped pipe a distance of at least three feet. Secure the end with circumferential turns of tape.
9. Taps: Wrap 3 layers of adhesive tape over the polyethylene, covering the area where the tapping machine will be mounted. Mount the machine over the tape. Make the tap and install the corporation stop through the tape and polyethylene. After making the service connection, inspect the polyethylene, and repair damaged areas with tape.



END OF SECTION 33 11 13.13

SECTION 33 13 00**WATER MAIN TESTING, DISINFECTION, AND DECHLORINATION**

PART 1 - GENERAL

1.01 SECTION DESCRIPTION

- A. This section provides for the required procedure for the water main testing, disinfection, and dechlorination prior to placing in service.

1.02 SECTION INCLUDES

- A. Corporation Cocks
- B. Hydrostatic Testing
- C. Disinfection of Water Mains

1.03 REFERENCES

- A. Current version at time of bidding of AWWA C651 - Standards for Disinfecting Water Mains.

PART 2 - PRODUCTS

2.01 CORPORATION COCKS

- A. The Contractor will furnish and install a three-fourth inch (3/4") Corporation cock to be used in the testing and disinfection of each new main. The location of these corporation cocks shall be as directed by the WSD.
- B. After the line has been tested and prior to placing the main in service, the Contractor shall remove the corporation cock and replace it with a tapered brass plug.

PART 3 - EXECUTION

3.01 HYDROSTATIC TESTING

- A. General
 1. The entire main shall be tested (pressure test and allowable leakage test) immediately after construction as directed and witnessed by the WSD.
 2. With approval of the WSD, the pressure test and leakage test may be conducted simultaneously. However, should the Contractor be granted permission to make both tests simultaneously, the required test pressure shall be equal to or greater than that for pressure tests as specified below.

B. Pressure Test

1. After the trench has been backfilled, the test connections made and the main filled with water, a minimum pressure of not less than the normal operating pressure (for the lowest point on the line) plus 50% for surge but in no case less than 150 psi, unless otherwise stated, shall be maintained on the new water main for at least two (2) hours.
2. The Contractor shall furnish all pumps, piping, gauges, labor and other materials and services necessary to bring the main up to the specified test pressure.
3. All exposed pipe, fittings, valves, hydrants and joints shall be inspected by the WSD and all evidence of moisture appearing on the surface of the ground during the test shall be investigated by the Contractor by excavation where the pipe has been covered with backfill.
4. All defective pipe, fittings, valves or hydrants discovered during the pressure test shall be removed and replaced by the Contractor and the pressure test shall be repeated until satisfactory to the WSD.
5. The Contractor shall furnish and install all temporary blow-off assemblies, fittings, thrust blocks, and restraining devices required for temporary connections for flushing, pressure testing, chlorination, and de-chlorination of water mains.

C. Leakage Test

1. An allowable leakage test shall be conducted after the pressure test has been satisfactorily completed. The Contractor shall maintain a minimum pressure in the new water main of 150 psi (or a minimum of 10 psi greater than the normal operating pressure of the system, if the normal operating pressure is lower than 140psi) for the lowest point on the line for at least two (2) hours.
2. Leakage shall be defined as the quantity of water that must be supplied into the newly laid pipe to maintain the specified leakage test pressure after the air has been expelled and the pipe has been filled with water.
3. No water main, or section thereof will be accepted if and while it has a leakage rate in excess of that determined by the following formula:

$$L = .0000075 SD (P)^{1/2} / 2$$

Where:

L = Maximum permissible leakage in gallons for two hours.

S = Length of pipe tested, in feet.

D = Nominal internal diameter of the water main being tested in inches.

P = Average test pressure in psi in the water main being tested.

4. Should the actual leakage exceed the allowable leakage, the test pressure shall be maintained for an additional period of time as directed by the WSD so that the leakage location may be detected.

3.02 DISINFECTION OF WATER MAINS

A. General

1. After completion of hydrostatic testing the Contractor shall flush and disinfect the entire main under the direction of WSD.
2. The Contractor shall prepare the main for disinfection by exposing the pipe at all entry points where the chlorine will be introduced into the pipe and installing temporary blow-offs at all discharge ends.
3. Continuous feed method of chlorination is required. The slug method of chlorination may be used only when directed by WSD.

B. Continuous Feed-Method

1. Water supplied from an approved source of supply shall be made to flow at a constant, measured rate into the new water main.
2. At a point not more than 10 ft downstream from the beginning of the new main, water entering the new main shall receive a dose of chlorine fed at a constant rate such that the water will have not less than 60 mg/L free chlorine. To ensure that this concentration is achieved, the chlorine concentration should be measured at regular intervals.
3. As an optional procedure, water used to fill the new water main during the application of chlorine shall be supplied through a temporary connection. This temporary connection shall be installed with an appropriate cross-connection control device for backflow protection of the active distribution system. Chlorine application shall not cease until the entire main is filled with heavily chlorinated water. The chlorinated water shall be retained in the main for at least 24 hours, during which time all valves and hydrants shall be operated to ensure disinfection of the appurtenances. At the end of this 24-hour period, the treated water in all portions of the main shall have a residual of at least 45 mg/L free chlorine.
4. The preferred equipment for applying liquid chlorine is a solution-feed, vacuum- operated chlorinator and a booster pump. The vacuum-operated chlorinator mixes the chlorine gas in solution water; the booster pump injects the chlorine-gas solution into the main to be disinfected. All connections shall be checked for tightness before the solution is applied to the main.
5. After the required retention period (24 hours), the heavily chlorinated water shall be flushed from the pipeline until chlorine measurements show that the water leaving the pipeline is no higher than that generally prevailing in the

system or is acceptable for domestic use. A reducing agent shall be applied to the water before discharging, to neutralize thoroughly the chlorine residual remaining in the water.

6. Contractor shall co-ordinate disinfectant testing and bacteriological testing to demonstrate that the above requirements have been met.

C. Slug Method

1. Water supplied from an approved source of supply shall be made to flow at a constant, measured rate into the new water main.
2. At a point not more than 10 ft downstream from the beginning of the new main, water entering the new main shall receive a dose of chlorine fed at a constant rate such that the water will have not less than 100 mg/L free chlorine. To ensure that this concentration is achieved, the chlorine concentration should be measured at regular intervals.
3. The chlorine shall be applied continuously and for a sufficient period to develop a solid column, or "slug" of chlorinated water that will, as it moves through the main, expose all interior surfaces to a concentration of approximately 100 mg/L for at least 3 hours
4. If at any time chlorine residual drops below 50 mg/L, the flow shall be stopped. Then the chlorination equipment shall be relocated at the head of the slug, and, as flow is resumed, chlorine shall be applied to restore the free chlorine in the slug to not less than 100 mg/L.
5. After the required retention period (at least 3 hours), the heavily chlorinated water shall be flushed from the pipeline until chlorine measurements show that the water leaving the pipeline is no higher than that generally prevailing in the system or is acceptable for domestic use. A reducing agent shall be applied to the water before discharging, to neutralize thoroughly the chlorine residual remaining in the water.
6. Contractor shall co-ordinate disinfectant testing and bacteriological testing to demonstrate that the above requirements have been met.

END OF SECTION 33 13 00

SECTION 33 31 13**POLYVINYL CHLORIDE (PVC) GRAVITY SEWER PIPE****PART 1 - GENERAL****1.01 SCOPE**

- A. This section covers all work, materials, and testing for installation of PVC gravity sewer pipe by the open-cut method as shown on the Drawings and in conformity with these specifications. All pipelines shall be constructed to proper line and grade as shown on the Drawings and shall result in an unobstructed, smooth and uniform conduit.

1.02 DESCRIPTION

- A. Sanitary sewer construction shall consist of furnishing all labor, materials and equipment for the complete installation of PVC gravity sewer pipe and appurtenances in accordance with Contract Drawings and these specifications.

1.03 SPECIFICATION MODIFICATIONS

- A. It is understood that throughout this section these Specifications may be modified by appropriate items in the Specific Project Requirements section of these specifications or on the Contract Drawings.

1.04 REVISIONS OF STANDARDS

- A. When reference is made to a Standard Specification, i.e., ASTM, ANSI, AWWA, the Specification referred to shall be understood to mean the latest revision of said specifications as amended at the time of the Notice to Bidders, except as noted on the Drawings or in the Specific Project Requirements section of these specifications.

PART 2 - PRODUCTS**2.01 MATERIALS****A. General:**

- 1. This section governs materials that may be required to complete pipeline construction, exclusive of structures, as shown on the drawings and/or as provided for in the Modifications to Detailed Specifications.

B. Requirements:

- 1. Furnish pipe materials, joint types, sizes, and strength classes indicated and specified. Higher strengths may be furnished at the Contractor's option at no additional cost to the Owner.

C. Manufacturer:

1. The manufacturer shall be experienced in the design, manufacture and commercial supplying of the specific material.

D. Inspection and Testing:

1. Inspection and testing shall be performed by the Manufacturer's quality control personnel in conformance with applicable standards. Testing may be witnessed by Owner, Engineer, or approved independent testing laboratory. The contractor shall provide certified test reports indicating that materials conform to these specifications.

2.02 PIPE, FITTINGS, JOINTS, COATINGS

- A. Type PSM Polyvinyl Chloride (PVC) Sewer Pipe and Fittings: Pipe and fittings 6 inch through 15 inch diameter pipe shall conform to ASTM D3034, except as otherwise specified herein.

1. GENERAL DESCRIPTION

- a. Furnish maximum pipe length normally produced by the manufacturer except for fittings, closures and specials.

2. MATERIALS

- a. The pipe shall be made of PVC plastic having a minimum cell classification of 12454C or 12454B, or 13364B, or 13364C as defined in ASTM D1784

3. DESIGN

- a. Pipe shall have an integral wall bell and spigot joint. Pipe shall have a minimum wall thickness conforming to SDR 21. If for any reason the depth of cover on SDR 21 pipe becomes greater than 29 feet, the contractor shall immediately notify the design engineer.

4. JOINTS

- a. Joints shall conform to ASTM D3212. Joints shall be push-on type only with the bell-end grooved to receive a gasket. Elastomeric seal (gasket) shall have a basic polymer of synthetic rubber conforming to ASTM F477. Natural rubber gaskets will not be accepted.

5. FITTINGS

- a. Fittings defined as tee or wye connections suitable for assembly to four (4) inch or six (6) inch building service lines shall be bell-end with a minimum wall thickness conforming to SDR 26 and shall be furnished by the pipe manufacturer.

- B. Polyvinyl Chloride (PVC) Large Diameter Plastic Gravity Sewer Pipe and Fittings, 18-inch through 36-inch diameters. Pipe and fittings shall conform to ASTM F679 except as otherwise specified herein.
1. GENERAL DESCRIPTION
 - a. Furnish maximum pipe length normally produced by the manufacturer except for fittings, closures and specials.
 2. MATERIALS
 - a. The pipe shall be made of PVC plastic having a minimum cell classification of 12454C or,13364C as defined in ASTM D1784
 3. DESIGN
 - a. Pipe shall have an integral bell gasketed joint to form a water tight seal. Pipe shall have a minimum wall thickness T-1 conforming to Table No. 1 of ASTM F679.
 4. JOINTS
 - a. Joints made with pipes and fittings shall show no sign of leakage, when tested in accordance with ASTM D3212. Joints shall be push-on type only with the bell-end grooved to receive a gasket. Elastomeric seal (gasket) shall have a basic polymer of synthetic rubber conforming to ASTM F477. Natural rubber gaskets will not be accepted.
 5. FITTINGS
 - a. The minimum wall thickness of the fittings shall be the same as the minimum wall thickness of the equivalent size of the pipe as specify in Table 1, ASTM F679.
 6. PIPE STIFFNESS
 - a. The pipe stiffness shall equal or exceed the minimum value listed in Table 1, ASTM F679 when tested at 5% deflection datum in accordance with Test method D2412.

PART 3 - EXECUTION

3.01 HANDLING

- A. Pipe and accessories shall be handled in a manner that will ensure their installation in the work in a sound, undamaged condition. Equipment, tools and methods used in unloading, reloading, hauling and laying pipe and fittings shall be such that the pipe is not damaged. Pipe having premolded joints shall be handled in such a manner that no weight, including the weight of the pipe itself, will bear on or be supported by the spigot end or bell end at any time. Pipe and pipe fittings which have

been damaged in any way will not be accepted and shall be removed from the project site.

3.02 LAYING PIPE

- A. Pipe shall be protected from lateral displacement by means of pipe embedment material installed as provided in the Earthwork section. Under no circumstances shall pipe be laid in water and no pipe shall be laid under unsuitable weather or trench conditions.
- B. When jointed in the trench, the pipe shall form a true and smooth line. Pipe shall not be trimmed except for closures, and pipe not making a good fit shall be removed.
- C. Pipe which is part of a gravity sewer line shall be aligned and constructed to grades as shown on the Drawings.

2. Alignment and Grade

- A. All pipe shall be laid straight between changes in alignment and at a uniform grade between changes in grade. All lines shall be laid so that each section between manholes will lamp.

3.02 JOINTING

A. Push-on gasketed joints

1. All instructions and recommendations of the pipe manufacturer, relative to gasket installation and other jointing operations, shall be observed and followed by the Contractor. All joint surfaces shall be heavily lubricated with vegetable soap solution immediately before the joint is completed.

3.04 CUTTING PIPE

- #### A. Cutting of pipe shall be done in a neat manner, without damage to the pipe. Pipe cuts shall be smooth, straight and at right angles to the pipe axis. All cutting of pipe shall be done with mechanical pipe cutters of an approved type except that in locations where the use of mechanical cutters would be impracticable, existing pipe may be cut with diamond point chisels, saws, or other tools which will cut the pipe without a damaging impact or shock.

3.05 CLEANING

- #### A. The interior of all pipe shall be cleaned of all foreign matter before being installed and shall be kept clean until the work has been accepted. All lumps, blisters and excess coating shall be removed from exterior spigot and interior bell surfaces. Such surfaces shall be wired brushed and wiped clean, dry, and free from oil and grease before placing the spigot in the bell. All joint contact surfaces shall be kept clean until the jointing is completed.
- #### B. Every precaution shall be taken to prevent foreign material from entering the pipe while it is being installed. No debris, tools, clothing, or other materials shall be placed in the pipe.
- #### C. Whenever pipe laying is stopped at the end of the work day, the open end of the line shall be sealed with a watertight plug. Whenever a tie-in to the existing collection system is made, a plug shall be installed in the new line to prevent water and/or debris from entering the existing collection system.

3.06 Pipe Embedment and Trench Backfill

- #### A. All pipe embedment and trench backfill shall conform to the Section 31 22 00 Site Preparation and Grading and Section 31 23 13 Subgrade Preparation of these specifications and the Contract Drawings, and Section 2507 Backfill, of Kansas City Metro American Public Works Association.

3.07 TESTING

- #### A. All pipelines shall be tested in accordance with Kansas City Metro American Public Works Association Section 2509 - Testing.

END OF SECTION 33 31 13

SECTION 33 39 13**SEWER MANHOLE CONSTRUCTION****PART 1 – GENERAL****1.01 SCOPE**

- A. This section covers standard sewer manholes. Standard manholes shall be constructed complete with covers, fittings, and other appurtenances, in accordance with the Kansas City, MO standard details.

1.02 GENERAL

- A. At the option of the Contractor, standard manholes may be constructed with cast-in-place bases or pre-cast concrete (developed) bases.

PART 2 - PRODUCTS**2.01 MATERIALS****A. Manhole Frames and Covers****1. Castings:**

- a. Tough, close-grained gray iron, sound, smooth, clean, free from blister, blowholes, shrinkage, cold shuts, and defects.
- b. Cast Iron: ASTM A48 Class 35B.
- c. Ductile Iron: ASTM A536, Grade 60-40-12.
- d. Plane or grind bearing surfaces to ensure flat, true surfaces.

2. Cover:

- a. True and seat within ring at all points.
- b. All manhole rings and cover shall be Kansas City, Missouri Standard, MH-RC, Type R3, latest revision.

- B. Non-shrinking Grout. Non-shrink grout shall be in the plastic state and show no expansion after set as tested in accordance with ASTM C827 and shall develop compressive strength not less than three thousand (3,000) psi with a trowelable mix within twenty-four (24) hours per ASTM C109. The placement time shall be not less than forty-five (45) minutes based on initial set per ASTM C191. Cormix "Supreme", L&M "Crystex", Master Builders "Masterflow 713 Grout" or "Set Grout", Sauereisen Cements "F-100 Level Fill Grout", UPCO "Upcon Super Flow", or U.S. Grout "Five Star Grout".

- C. Cast-in-Place Concrete. Materials, handling, forms, finishing, curing, and other work as specified in the concrete sections.

1. Class A concrete used for aerial crossing piers, wetwell walls, manhole walls, bases, inverts, and flat slabs shall have a 28-day strength of 4000 psi, unless otherwise specified.

2. Class B concrete used for concrete encasements and embedments, thrust blocks, pipe anchors, and pipe collars shall have a 28-day strength of 3000 psi, unless otherwise specified.
 - D. Pre-cast Concrete. Pre-cast concrete manholes shall conform to ASTM C478. Minimum wall thickness not less than one-twelve (1/12) of inside diameter, plus one inch or five (5) inches, whichever is greater.
 - E. Pre-cast Concrete Riser and Base Sections. Circular, uniform outside diameter; ASTM C478, except modified herein. Developed bases shall be used unless prior approval is obtained from the Engineer. The diameter of the base pad shall be eight (8) inches greater than outside diameter of the manhole.
 - F. Cone Sections. Eccentric, ASTM C478; wall thickness and reinforcement as specified for riser sections.
 - G. Manhole Adjusting Rings. Concrete or HDPE manhole adjustment rings shall be used. If HDPE manhole adjustment rings are used they shall be as supplied by Ladtech, Inc.
 - H. Reinforcement Steel. Welded Wire Fabric-ASTM A185. Reinforcing Bars- ASTM A615, Grade 40, or Grade 60. Fabricated Steel Bar and Rod Mats - ASTM A184, Grade 40, or Grade 60
 - I. Resilient Manhole/Pipe Connectors. Pipe openings shall contain flexible gaskets conforming to the requirements of ASTM C923. Mortar connections will be allowed only if prior approval has been given by the Engineer. Flexible gaskets shall be manufactured by the Press-Seal Gasket Corporation, A-Lok Products Inc., or approved equal. When RCP is used with A-Lok gasket, the barrel of the RCP shall be lubricated to prevent damage to the gasket during insertion. When PSX gaskets are used, the take-up screws for the gasket clamps shall be positioned a minimum of 90° apart. The specific type of gasket approved for each diameter is referenced in the table below.

Diameter (in.)	PSX	A-LOK	A-LOK: X-CEL	A-LOK PREMIUM
8	Yes	Yes	Yes	No
10	Yes	Yes	Yes	No
12	Yes	Yes	Yes	No
15	Yes	Yes	No	Yes
18	Yes	Yes	No	Yes
21	Yes	Yes	No	Yes
24	Yes	Yes	No	Yes
27	Yes	Yes	No	Yes
30	Yes	Yes	No	Yes
36	Yes	Yes	No	Yes
42	Yes	Yes	No	Yes
48	Yes	Yes	No	Yes

- J. Joint Sealant. Joints shall be sealed with two beads of preformed bitumastic sealants meeting the requirements of Federal Specification SS-S-210A. The minimum bead dimension shall be an inch square. The sealants shall be placed at the elbow of the section's joint. The sealant shall be butt-joined and not lapped.
- K. External Manhole Seal - Heat Shrinkable Wraparound Sleeves. In accordance with ANSI/AWWA C216-89. The wrap system shall consist of a two-piece sleeve (backing + adhesive) with a closure system and a G-type primer. It shall consist of an irradiated cross-linked polyolefin sheeting, pre-coated with a layer of anti-corrosion adhesive. The backing shall have a minimum recovery of 22%.
1. The wrap shall have a mastic-type adhesive, specially formulated to become fluid at temperatures achieved during installation and maintain flexibility in cold climates with installation temperatures down to -40°F. Upon cooling the adhesive shall form a tough, elastomeric protective layer. The wrap shall employ a closure seal to allow sealing of the overlap area. The overall thickness of an applied sleeve shall nominally measure 0.100" (2.5mm). The heat shrinkable wraparound sleeves shall be "Wrapid Seal" as manufactured by Canusa or approved equal.
 2. The sleeves shall be installed according to the following procedure:
 - a. Ensure surface to be covered is free of dirt, sharp points, and preheated to remove moisture. Apply the primer over all areas to be covered and let dry. (5-15 min.)
 - b. Cut a length of sleeve twelve inches longer than the exterior circumferential distance around the manhole measured at each joint or manufacturers recommendation. The wrap shall extend six (6) inches above each joint and six (6) inches below each joint on the exterior

- surface of the manhole. The wrap applied to the cone section and casting shall be eighteen (18) inches wide.
- c. Wrap the sleeve around the manhole. Position the self-adhering closure seal at the overlap. Heat the overlap area and pat down with a gloved hand to ensure bonding. Heat the sleeve until the entire sleeve has recovered. Smooth out the wrinkles. Quench with water or allow to cool prior to backfilling for the adhesive to set.
- (i) For castings installed above ground contractor shall grout between the gussets to create a bevel with a 3000 psi mix of (small aggregate 3/8" max) concrete to insure the heat shrinkable wraparound sleeve in making contact to entire surface area of chimney section. The wraparound sleeve should be fitted to overlap the grouted area at least 2-inches above grouted slope. Contractor shall then install a stainless steel band around top and bottom of wraparound sleeve to insure security of sleeve. Contractor shall then paint heat shrinkable wraparound sleeve with white latex paint after installation of sleeves and bands.
- (ii) For castings below ground level the contractor will cut the heat shrinkable wraparound sleeves around casting gussets and secure to frame.
- L. Internal Sealing System. All flattops manholes shall only have a Cretex Internal Seal installed in them for the entire chimney section. Manholes frame-chimney joint area can be sealed with an internal flexible rubber seal, as manufactured by Cretex Specialty Products, or approved equal. The flexible rubber sleeve, extensions and wedge strips shall be extruded or molded from a high grade rubber compound conforming to the applicable requirements of ASTM C-923, with a minimum 1500 psi tensile strength, maximum 18% compression set and a hardness (durometer) of 48 +or- 5.
1. The sleeve shall be either double or triple pleated with a minimum unexpanded vertical height of 8" and 10" respectively, a minimum thickness of 3/16" and shall be capable of a vertical expansion when installed of not less than 2." The top and bottom section of the sleeve shall contain an integrally formed expansion band recess and multiple sealing fins.
 2. The extension shall have a minimum thickness of 3/16." The top section of the extension shall be shaped to fit into the bottom band recess of the sleeve under the bottom chimney seal band. The bottom section of the extension shall contain an integrally formed expansion band recess and multiple sealing fins matching that of the rubber sleeve.
 3. Any splice used to fabricate the sleeve and extension shall be hot vulcanized and have a strength such that the sleeve shall withstand a 180 degree bend with no visible separation.
 4. The continuous wedge strip used to adapt the rubber sleeve to sloping surfaces shall have the slope differential needed to provide a vertical band

recess surface, be shaped to fit into the band recess and have an integral band restraint. The length of the wedge strips shall be such that, when its ends are butted together, it will cover the entire inside circumference of that band recess needing slope adjustment.

5. The expansion bands used to compress the sleeve against the manhole shall be 16-gauge stainless steel conforming to ASTM A-240, Type 304, with a minimum width of 1-3/4." The expansion mechanism shall have the capacity to develop the pressures necessary to make a watertight seal and shall have a minimum adjustment range of 2 diameter inches. Studs and nuts used for this mechanism shall be stainless steel conforming to ASTM F-593 and 594, Type 304.
 6. Elastomeric polyurethane resin-saturated oakum can be substituted for the butyl rubber elastic material. The material shall be able to withstand hydrogen sulfide and other corrosive gases. The material shall be installed in a double row circumferentially at each joint. For the resin-saturated oakum system, the outer ring shall be saturated with a urethane base foam chemical sealing material. The inner ring shall be saturated with water and shall be placed to prevent urethane foam from entering the manhole.
- M. Mastic Fill Gaskets. Mastic filler shall be butyl rubber compatible with resilient connector material, or Rapid Seal.
- N. Rubber. ASTM C361, Section 6.9.1, except gasket shall be synthetic, with hardness of 40 ± 5 when measured by ASTM D2240, Type A Durometer.
- O. Waterproofing. Exterior surfaces shall be coated with one of the following approved coatings:
1. A total dry film thickness of not less than 14.0 mils of Anchor-Tite Uni-Seal Asphalt Dampproofing Liquid Grade.
 2. A total dry thickness of not less than 4.0 mils of Tnemec Series 66 Hi-Build Epoxiline.
- P. Castings. ASTM A48, Class 35B or better. Kansas City, Missouri Standard, MH-RC, Type R3, latest Revision.
- Q. Manhole Steps. Manhole Steps shall be plastic coated.

PART 3 – EXECUTION

3.01 MANUFACTURE

- A. Pre-cast base sections shall be provided with circular openings, with continuous, circular, resilient connectors cast into the wall.

- B. Resilient connectors shall be installed in accordance with the manufacturer's recommendations, except that connectors shall be positioned so that sealing or resealing operations may be accomplished from inside the manhole.
- C. Pre-cast sections may be provided with lifting notches on the inside faces of the walls to facilitate handling. Lifting notches shall be not more than 3 inches deep; holes extending through the wall will not be acceptable.
- D. If pre-cast concrete base sections are used, part of the concrete invert fill may be furnished with the pre-cast unit; however, a rough surface shall be provided to improve bond with the final invert fill. At least the top 2 inches of the concrete invert fill shall be installed in the field.

3.02 DELIVERY

- A. Pre-cast concrete sections shall not be delivered to the job until the concrete control cylinders have attained a strength of at least 80 percent of the specified minimum.

3.03 HANDLING

- A. Pre-cast concrete sections shall be handled carefully and shall not be bumped or dropped. Hooks shall not be permitted to come in contact with joint sections.

3.04 INSPECTION

- A. Pre-cast concrete sections shall be inspected when delivered and all cracked or otherwise visibly defective units rejected. Owner reserves the right to inspect the production of the units at the manufacturing plant.

3.05 MANHOLE EXCAVATION

A. Excavation

- 1. This Section and Section 31 22 00 shall govern excavation for manholes and special structures. It shall be achieved in a suitable and orderly manner providing a minimum disturbance to the general public.

B. Depth of Excavation

- 1. Depth of excavation shall be to that required for proper installation of the manhole or structure. Over-depth excavation may be required by the Engineer if the subgrade is unstable. Over-depth excavation due to unstable subgrade shall be backfilled as required by the Engineer. Over-depth excavation occurring through an oversight by the Contractor shall be backfilled as required by the Engineer at no additional cost to the Owner.

C. Side Clearances

- 1. Side clearance outside the manhole and/or structures shall be no greater than to allow for forming connection of piping, proper application of special coatings,

if required, and to permit inspection. When concrete is to be placed directly against excavated faces, excavation shall be sufficiently outside of the manhole or structure to provide not less than three (3) inches of concrete cover over the steel reinforcement.

3.06 MANHOLE INSTALLATION

A. Bases

1. If developed bases cannot be used, poured concrete bases shall be used. Cast-in-place concrete bases shall have a minimum thickness of eight (8) inches. Concrete shall be placed on undisturbed earth in accordance with requirements of the concrete section. The bottom wall section shall be embedded in the base section a minimum of four (4) inches. The bottom pre-cast wall section shall not be used for supporting or leveling the other wall sections prior to pouring the base. Concrete blocks shall be used for supporting or leveling the bottom wall section prior to pouring the base. Use of Wood blocks will not be accepted.
 2. If pre-cast concrete (developed) bases are used, the subgrade materials shall be excavated to undisturbed earth and a uniform elevation which will permit at least 4 inches of crushed rock, as specified in the earthwork section, to be installed and compacted. The surface of the granular material shall be carefully graded and the base section accurately set so that connecting pipes will be on proper line and grade. The elevation of the granular material shall be adjusted as required until proper grade and alignment of the base section has been attained.
 3. No wedging or blocking under pre-cast concrete bases will be permitted.
 4. When resilient connectors are used with cast-in-place bases, the concrete fill under the connecting pipe outside the manhole shall be deleted and shall be replaced with granular embedment material to undisturbed earth.
 5. In no case shall the invert section through a manhole be greater than that of the outgoing pipe. The shape of the invert shall conform exactly to the lower half of the pipe it connects. Side branches shall be connected with as large radius of curve as practicable. All inverts shall be troweled to a smooth, clean surface.
- B. Riser and Cone Sections. Circular pre-cast sections shall be provided with a rubber or mastic gasket to seal joint between sections. Lifting notches in manhole walls shall be filled with non-shrinking grout. The minimum horizontal clear distance in the barrel of the manholes shall not be less than four (4) feet unless otherwise specified on the Drawings.
- C. Connecting Piping. The space between connecting piping and the wall of the pre-cast sections shall be completely filled with non-shrinking grout, except where resilient connectors are provided.

1. When resilient connectors are used, the connecting pipe shall be carefully adjusted to proper line and grade, and bedding material shall be compacted under the haunches and to the springline of the pipe for a distance of at least 6 feet from the manhole wall and to at least the minimum trench width. The pipe shall be installed in the resilient connector prior to backfilling outside the manhole and shall be resealed as required after completion of the manhole and backfill. All visible leakage shall be eliminated.
 2. The connecting pipe for installation with resilient connectors shall be plain end, square cut spigots and shall not protrude more than one inch inside the manhole wall. A clear distance of at least one-inch from the end of each connecting pipe and around the pipe shall be provided when the concrete invert fill is installed or as recommended by the manufacturer of the resilient connector. After completion of the manhole, the boxout shall be filled with mastic filler material, completely filling the space beneath the pipe and extending to at least the springline. The filler material shall provide a smooth, uniform surface between the inside diameter of the pipe and manhole invert.
- D. Inverts. Inverts shall structural concrete and steel-troweled (or formed if inverts are pre-cast) to produce a dense, smooth finish. The invert channel shall be "U-shaped" in cross section and extend upward three-fourth of the inside pipe diameter. Smooth transitions shall be formed for pipes of different sizes, elevation, and bends. The invert bench shall be constructed with a 4:1 slope to drain and built to accommodate CCTV equipment.
- E. Steps. Steps shall be aligned vertically below the casting and spaced at sixteen (16) inch centers. The top step shall be not more than one (1) foot below the top of the cone. The lowest step shall be not more than two (2) feet above the invert bench. Field drilled step holes are not permitted in pre-cast concrete manhole. Manhole steps shall meet the following requirements:
1. Minimum 1/2 inch diameter steel reinforcing bar: ASTM A615
 2. Grade 60 or deformed wire: ASTM A496
 3. Encase in polypropylene: ASTM D4101
- F. Top Elevation. The finished top elevation of manhole castings shall conform to the following unless otherwise shown on the Drawings or directed by the Engineer.
1. In paved or future paved areas, the top of the casting shall conform to the slope of the pavement and be 1/8 inch below the finished pavement elevation.
 2. In non-pavement areas, the top of the casting shall be not more than six (6) inches above the surrounding ground or less than the sod's upper root limit. The final elevation shall be at a point where water will not pond over the manhole cover.
- G. Manhole Adjustment. All new manholes will be provided with adjustment ring(s) underneath the casting as shown on drawings. A maximum of one (1) 6-inch or two (2) 4-inch riser rings shall be installed on top of the cone section. The joints shall be

sealed with a double bead preformed bitumastic sealant. If the top of an existing manhole is required to be raised to an elevation which will exceed twelve (12) inches, or lowered more than the adjustment rings will allow, all vertical adjustments shall be made to the barrel of the manhole.

- H. Castings. Casting shall be installed with the mud ring inserted inside the manhole opening and resting on a minimum of two rows of preformed bitumastic joint sealant.

3.07 DAMPPROOFING

- A. Dampproofing may be applied to pre-cast units in the shop. If the shop coating is damaged during construction, a touch up coat of paint as required shall be applied and allowed to dry prior to backfilling. Surfaces to receive paint shall be dry.

3.08 DRAWINGS AND DATA

- A. Drawings and data covering pre-cast concrete sections shall be submitted in accordance with the submittals section.

3.09 MANHOLE TESTING

- A. The Contractor shall shall test all pipes and manholes in accordance with APWA Section 2509 – Testing and APWA Section 2510.9 Manhole Testing, respectively.

END OF SECTION 33 39 13

SECTION 33 40 00**STORM DRAINAGE UTILITIES****PART I - GENERAL****1.1 SUMMARY****A. Description**

1. This Work consists of furnishing and installing storm drainage pipes and structures as shown and as specified herein. This Work also includes joints and connections on the Contract Drawings to other drainage structures or systems, and temporary storm drainage measures during construction.
2. The Contractor has the option of using pipe of different materials. The Contractor may substitute stronger, and higher quality material at any installation site, provided the substitution is approved by the local government agency (where applicable), and the Engineer.
3. The nominal sizes of pipe are shown on the Contract Drawings. The actual diameters and thickness will be determined according to AASHTO and ASTM tolerances for different pipe diameters for the appropriate kind and class of pipe.

B. Related Sections

1. 02 40 00 - Demolition and Removal of Structures
2. 33 05 13.13 - Adjustment of Incidental Structures
3. 31 23 33 – Trenching, Backfilling and Compacting for Utilities
4. 31 22 00 – Site Preparation and Grading
5. 32 11 00 - Aggregate Base Course
6. 31 05 19.13 – Geotextiles for Earthwork, Filling, and Backfilling
7. 33 49 13 – Storm Structures
8. 03 20 10 - Concrete Reinforcement
9. 03 30 00 - Cast-In-Place Concrete
10. 05 50 00 - Metal Fabrications

1.2 REFERENCES

<u>Sponsor</u>	<u>Number</u>	<u>Subject</u>
AASHTO	M 31	Plastic Coating
AASHTO (ASTM C 14)	M 86	Concrete Sewer, Storm Drain, and Culvert Pipe

AASHTO (ASTM A 27)	M 103	Steel Castings, Carbon, for General Application
AASHTO (ASTM A 48)	M 105	Gray Iron Castings
AASHTO (ASTM A 123)	M 111	Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
AASHTO (ASTM C 76)	M 170	Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
AASHTO (ASTM A 36)	M 183	Structural Steel
AASHTO	M 190	Manhole Step
AASHTO (ASTM	M 196 B 745)	Corrugated Aluminum Pipe for Sewers and Drains
AASHTO	M 198	Joints for Circular Concrete Sewer and Culvert Pipe Using Flexible Watertight Gaskets
AASHTO (ASTM	M 199 C 478)	Precast Reinforced Concrete Manhole Sections
AASHTO (ASTM	M 227 A 663)	Steel Bars, Carbon, Merchant Quality, Mechanical Properties
AASHTO (ASTM	M 242 C 655)	Reinforced Concrete D-Load Culvert, Storm Drain, and Sewer Pipe
AASHTO	M 270	Steel Reinforcing
AASHTO	M 294	Corrugated Polyethylene Drainage Tubing, 12" to 36" Diameter
AASHTO	A 780	Repair of Damaged Hot-Dip Galvanized Coatings
ASTM	C 985	Non-reinforced Concrete Specified Strength Culvert Storm Drain and Sewer Pipe
ASTM	D 113	Ductility of Bituminous Materials
ASTM	D 3034	Type PSM PVC Sewer Pipe
AWS	D 1.1	Structural Welding Code - Steel
Fed. Spec.	SS-S-00210	Sealing Compound, Preformed Plastic, for Expansion Joints and Pipe Joints
ASTM	F 714	Standard Specifications for Polyethylene Plastic Pipe Based on Outside Diameter
ASTM	D 3350	Specification for Polyethylene Plastic Pipe and Fittings Material

ASTM	F 1248	Determination of Environmental Stress Crack Resistance (ESCR) of Polyethylene Pipe
ASTM	C 850	Precast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewers

1.3 SUBMITTALS

- A. Submittals shall be made in accordance with the requirements of the Project Quality Plan, except as modified herein.
1. Details of concrete pipe joints and special sections.
 2. Details of precast concrete components.
 3. Details of metal components for manholes.
 4. Details of catch basins.
 5. Details of HDPE Pipe to manhole connection.
- B. Product data shall be submitted for the following:
1. Reinforced Concrete Pipe and Joint Material
 2. Rubber gaskets.
 3. Galvanized Corrugated Metal Pipe
 4. PVC and High Density Polyethylene pipe and fittings.
 5. Single wall, fully corrugated polyethylene drainage pipe.
 6. Fully corrugated polyethylene with smooth internal diameter wall pipe.
 7. Precast Reinforced Concrete Box Sections.

1.4 QUALITY ASSURANCE/QUALITY CONTROL

Precast components shall be manufactured by firms with at least 5 years experience in manufacturing component of this type required by the contract.

PART II - PRODUCTS

2.1 MATERIALS

Cast-in-place concrete shall be in accordance with the requirement of Sections 03 20 10 and 03 30 00.

2.2 PVC PIPE

Use PVC pipe conforming with: ASTM D3034 SDR 35, 4-15" Diameter where shown on the Plans.

2.3 CONCRETE PIPE

- A. Nonreinforced or plain circular concrete pipe and special sections shall conform to the requirements of AASHTO M 86 (ASTM C 14) or ASTM C 985 except as follows:
1. Where rubber gasket joints are used, the design of the ends of the pipe sections shall be modified according to AASHTO M 198 to accommodate rubber gaskets.
 2. Indent the markings required by AASHTO M 86 (ASTM C 14) in the outside surface of each section of pipe.
- B. Reinforced concrete pipe and special sections shall conform to the requirements of AASHTO M 170 (ASTM C 76) except as follows:
1. Where rubber gasket joints are used, modify the design of the ends of pipe sections according to AASHTO M 198 to accommodate rubber gaskets.
 2. Special sections such as elbows, wyes, tees, crosses, bend, and reducers shall be as shown, specified, or directed. In the absence of any design or specifications, the special sections shall be of the design recommended by the manufacturer for the intended use. Generally the special sections shall conform to the requirements specified for the pipe with which it is to be used. Special sections with components shall be from tested and approved lots. Production dates shall be available for such sections.
 3. Indent the markers required by AASHTO M 170 (ASTM C 76) in the outside surface of each section of pipe.
 4. Reinforced concrete pipe having the same D-load strengths as those specified to be furnished under AASHTO M 170 (ASTM C 76) may be furnished according to AASHTO M 242 (ASTM C 655).
 5. The basis of acceptance for pipe, manufactured according to AASHTO M 170 (ASTM C 76), and AASHTO M 242 (ASTM C 655), shall be load bearing tests, material tests, and inspection of manufactured pipe for visual defects and imperfections, unless other basis are approved.

2.4 METAL PIPE

- A. Corrugated steel pipe, helical rib pipe and special sections shall conform to the requirements of AASHTO M 36, (ASTM A 760) Type I, IA, and II, except as follows:
1. Shape shall be full-circle, unless otherwise stated. The shapes of pipe fabricated and furnished may include any of the following:
 - a. Full circle fabricated helical rib pipe in full-circle cross section only.
 - b. Half circle pipe fabricated as half sections of full-circle pipe of the same diameter.
 2. Connecting bands shall be used to make field joints for pipes not requiring water tight joints. Coating damage on edges of bands need not be repaired.
 3. Joints shall be welded according to recognized standard practice and any damaged zinc or aluminum coating repaired as specified herein.
 4. For repair of damaged coating in addition to the methods given in AASHTO M 36 (ASTM A 760) the Contractor may, at his option, repair damaged zinc or

aluminum coating by removing all loose or cracked coating, removing all welding flux, wire brushing the damaged area, and applying 2 coats (min. 2 mils total thickness each) of a high zinc dust content paint conforming to the general requirements of ASTM A 780. Damaged zinc or aluminum coating, within 3/8-inch of the ends of pipe sections, caused by production cut-off of pipe will be permitted without repair.

5. Sloped and skewed ends shall be fabricated to provide a smooth surface, and coating shall be restored as specified herein.

2.5 HIGH DENSITY POLYETHYLENE PIPE

- A. High density polyethylene (HDPE) pipe shall be submitted and approved by Engineer. Pipe size shall be as shown on plans. All pipe sizes as shown on the drawings and as specified herein are in reference to "nominal" diameter, unless otherwise indicated. Pipe sizing is to be according to ASTM F714 and ASTM D 3035. The pipe shall be made from Premium High Density Polyethylene resin qualified as Type III, Category 5, Class C, Grade P34 in ASTM D1248. This material shall have a long term hydrostatic strength of 1600 psi when tested and analyzed by ASTM D2837, and listed by the Plastic Pipe Institute as a PE 3408 Resin.
- B. The following minimum engineering design specifications are required:
 1. ASTM D-638 Tensile Strength Yield (2 in/min), >3200 P.S.I.
 2. ASTM D-638 Elongation at break, 750%
 3. ASTM D-638 Modulus of Elasticity, 105,000 P.S.I.
 4. ASTM D-3350 Flexural Modulus, 125,000 P.S.I.
 5. ASTM D-1693 Environmental stress crack resistance Condition C, >5000 F 20 hrs.
 6. ASTM D-2837 Long Term High Strength (L.T.H.S.) @ 73.4⁰ F, 1600 P.S. I.
- C. The pipe shall contain no recycled compound except that generated in the manufacturer's own plant from resin of the same specification from the same raw material supplier.
- D. The polyethylene pipe shall be homogeneous throughout and free of visible cracks, holes, foreign inclusions, or other injurious defects. The pipe shall be uniform in color, opacity, density, and other physical properties.
- E. The following information shall be continuously marked on the pipe or spaced at intervals not exceeding five (5) feet:
 1. Name and/or trademark of the pipe manufacturer.
 2. Nominal pipe size.
 3. Standard Dimensional Ratio (SDR).
 4. PE 3408.
 5. Manufacturer's Standard reference.

6. A production code from which the date and place of manufacture can be determined.
- F. Compliance with the requirements of these specifications shall be certified in writing by the pipe supplier.

2.6 HDPE PIPE JOINTS

- A. All HDPE pipe and fittings shall be jointed by the butt fusion process per ASTM D 2657 and the manufacturer's specific recommendations. The tensile strength at yield of the butt-fusion joints shall be not less than the pipe.
- B. HDPE bead removal: The bead on the inside of the pipe resulting from the fusion process shall be removed flush with the inside surface of the pipe with a cutting tool specifically designed for this purpose.
- C. HDPE Couplings: Mechanical connections of polyethylene pipe to fittings or other materials shall be by means of flanged connections (flanged coupling adapters and ANSI backup rings rated for the same pressure service as the system piping) or flexible couplings designed for joining polyethylene pipe to polyethylene pipe or to another piping material as applicable. Flanged joints shall use bolts of compatible material. Gaskets shall be required when joining to non-polyethylene materials. In all cases, the bolts shall be evenly torqued using a cross pattern. Flanged joints are to be retorqued after one hour or more has passed.
- D. Manholes on HDPE Pipe: Approved water stops or flange anchors shall be used where the pipe enters and exits the manhole.

2.7 JOINT PROOF TESTS

- A. General
 1. The intent of this requirement is to prequalify a joint system, components of which meet the joint requirements, as to the water tightness capability of that joint system. This proof test shall be understood to apply to all sanitary sewers and to storm drains which are to be tested for water tightness prior to acceptance. Material and test equipment for proof testing shall be provided by the manufacturer. Joints shall meet the requirements of yard testing specified below. The pipe manufacturer shall submit results of the yard tests made, certified by a testing agency approved by the Engineer. When approved, internal hydrostatic pressure may be applied by a suitable joint tester. In general, each pipe material and joint assembly shall be subject to the following three proof tests at the discretion of the Engineer:
 - a. Pipe in Straight Alignment: No less than three nor more than five pipes selected from stock by the Engineer shall be assembled according to the manufacturer's installation instructions with the ends suitably plugged and restrained against internal pressure. The pipe shall be subjected to 10 psi hydrostatic pressure for 10 minutes. Free movement of water through the pipe joint or pipe wall shall be grounds for rejection of the pipe.
 - b. Pipe in Maximum Deflected Position: A test section shall be deflected as described hereinafter for each pipe material. The pipe shall be subjected to 10 psi hydrostatic pressure for 10 minutes. Free movement of water

through the pipe joint or pipe wall shall be grounds for rejection of the pipe.

- 1) For deflected position, join 12 ½ foot lengths, then deflect along an arc or 720 feet radius (0.11 feet offset at the end of each length from a tangent at the joint).
- c. Joints Under Differential Load: The test section shall be supported on blocks or otherwise as described hereinafter for each pipe material. There shall be no visible leakage when the stressed joint is subjected to 10 psi internal hydrostatic pressure for 10 minutes.
- 1) For differential load, join two lengths and uniformly support for at least 2 feet on both sides of the joint with vertical load applied sufficient to deflect the joint and adjacent pipe to 95% of its initial vertical diameter.
2. An alternative to the internal hydrostatic pressure test would be an external hydrostatic test or a vacuum test effectively meeting the same time and pressure requirements as determined by the Engineer.

2.8 FITTINGS

A. General

1. Provide tee and wye fittings in the storm sewer main for service line sewers and catch basins or inlet connections. Tees and wyes for service line sewers shall be the same diameter as the pipe which they join, unless otherwise specified. All fittings shall be of sufficient strength to withstand all handling and load stresses encountered. All fittings shall be of the same materials as the pipe unless otherwise specified. Material joining the fittings to the pipe shall be free from cracks and shall adhere tightly to each joining surface. Use the same type of joints on all fittings that are used on the main sewer pipe, unless approved by Engineer.

C. HDPE Pipe

1. Standard fittings and special fittings shall be manufactured from the same class of material as the pipe is manufactured and be fully compatible.
2. Fittings shall be manufactured in accordance with ASTM 3197 or ASTM D 3261. Fabricated fittings shall be pressure rated to match the system piping.
3. Tee and wye fittings to connect existing service laterals to HDPE pipe shall be either molded butt fusion fittings, or molded saddle fusion fittings.

2.9 MANHOLES, CATCH BASINS AND HEADWALLS

- A. Earthwork: Excavation and backfill shall be in accordance with the requirements of Sections 31 22 00 as appropriate.
- B. Cast-In-Place Concrete: Cast-in-place concrete shall be in accordance with the requirements of Sections 03 20 10 and 03 30 00.
- C. Precast concrete sections shall conform to the requirements of Section 33 49 13 and the following:

1. The precast risers, cones and cover slabs for precast concrete manholes shall conform to the requirements of AASHTO M 199 (ASTM C 478) and be rated for H-20 loading.
2. The precast rings and lids for precast concrete inlets shall be of portland cement concrete conforming to AASHTO M 199.

D. Metal Items.

1. Metal frames, covers, grates, and ladders shall conform to the following:

AASHTO/ASTM

<u>Item</u>	<u>Designation</u>	<u>Grade</u>
Manhole frames and cover inlet frames and grates	M 105/A 48	Class 30B
	M 277/A 663	65
	M 183/A 36	-
	M 103/A 27	65-35
Manhole ladder rails	M 183/A 36	-
	M 227/A 663	65

2. Steps for manholes and rungs for manhole ladders from structural steel having a minimum yield strength of 28,000 psi and be galvanized according to AASHTO M 111 (ASTM A 123).
3. Welding shall conform to AWS D1.1.
4. Frames, covers and grates shall have even and uniform bearings where they come in contact with each other.
5. Miscellaneous metal items and hardware shall conform to the appropriate requirements of Section 05 50 00.

E. Manhole Steps

1. Manhole steps shall conform with AASHTO designation M-190 unless noted otherwise. Steps shall not be installed in storm sewer manholes or boxes that are 6 feet deep or less to pipe flowline.
2. Steel reinforcing of manhole steps shall conform to AASHTO designation M-270, grade 36. Plastic coating of manhole steps shall conform to AASHTO designation M-31, grade 60.

2.10 JOINT MATERIALS

- A. Rubber Gaskets: Rubber gaskets for concrete pipe and precast section joints shall conform to the requirements of AASHTO M 198.
- B. Joint Mortar: Joint mortar for concrete pipe joints and precast manhole section joints shall consist of one part portland cement and two parts approved sand with water, as necessary, to obtain the required consistency. Mortar shall be used within 30 minutes after preparation unless conditions during use necessitate a shorter time.

- C. Plastic Compound: Plastic compound for precast manhole section joints shall be a compound that:
1. Has a putty-like, preformed homogeneous blend of hydrocarbon resins and rubber or plasticizing materials with not more than 50% by weight of inert mineral filler.
 2. Is specifically manufactured for the intended use and pliable and temperatures between 32°F and 135°F and ½ inches square in cross section shall stretch at least 1-1/2 inches before rupture when tested with the apparatus described in ASTM D 113.
 3. Adheres firmly and cohesively to the precast manhole sections when the compound-sealed joint is flexed to its maximum extent.
 4. Includes for use, a primer solution recommended by the compound manufacturer.
 5. Conforms with Federal Specification SS-S-00210 (GSA-FSS).

PART III - EXECUTION

3.1 PIPE

- A. Earthwork: Excavation, bedding, backfilling and compacting shall conform to the requirements of Section 31 22 00.
- B. Installation in Paved Areas
1. General: Pipes shall be installed within paved areas that are to be preserved by open excavation, tunneling, jacking, or boring methods as the Contractor elects. Regardless of the method used, the adjoining pavement shall not be damaged.
 2. Open Cut:
 - a. Pavement Cuts
 - 1) Pavement shall be vertically saw cut along each edge of the area to be removed when no pavement overlay will occur or when the surface is carrying traffic. All other pavements may be either saw or wheel cut.
 - 2) The area being cut shall be limited to the least width and extent practical for installation. Cuts shall be clean, vertical and made true to lines designated within a tolerance of 1 inch. Depths of the cuts shall be sufficient to permit the removal of pavement between or alongside them without damage to pavement or structures to be left in-place.
 - 3) Pavement lying within the limits of the cuts and from any adjoining areas damaged by the cutting and removal operation shall be removed and disposed of according to Section 02 40 00.
 3. Replacement Surfacing

- 1) Aggregate base shall be placed and compacted after trench backfill is completed in accordance with Section 32 11 00. Aggregate base shall be 18 inches thick or the thickness of the removed base whichever is greater.
- 2) Pavement shall correspond with the kind and thickness removed. Shoulders, driveways, curbs, gutters, walks, dikes, walls and other similar asphalt or portland cement concrete structures shall be replaced with construction at least equal in all respects to that of the structures or parts of structures removed, similar and matching that of adjoining, undisturbed structures.
- 3) Replacement work shall be performed as follows:
 - a) Trim all loose fragments from abutting edges of old pavement.
 - b) Apply asphalt tack coat to edges of existing asphalt concrete.
 - c) Thoroughly moisten edges of old portland cement concrete with water.
 - d) Place, shape, compact, and finish the asphalt or portland cement concrete to established grade and cross section.
 - e) Respective thicknesses of new pavement shall equal removed pavement thickness or the following, whichever is greater:

**Minimum Compacted
Thickness, Inches**

<u>Kind</u>	<u>Traveled-Way Area</u>	<u>Other Areas</u>
Asphalt Concrete	5	4
Portland Cement Concrete	8	8

- 4) Pavement shall be opened, pipe installed, area repaved, and traffic resorted in the same day or trench covered with a steel plate or temporary surfacing as approved. Temporary surfacing shall be graded to proper cross section.

C. Laying

1. Pipe shall be laid beginning at the downstream end of the line with the bottom in contact with shape bedding throughout its full length except where bell holes are required. Pipe shall be placed with bell or female grooved ends facing upstream.
2. Round elliptically reinforced concrete pipe shall be placed so that manufacturer's marks designating top and bottom of pipe are within 5 degrees of a vertical plane through the longitudinal axis of the pipe.

D. Joining

1. Field joints made in joining pipe sections and connecting pipe to structures shall:
 - a. Provide equal or greater strength than the adjoining pipe.
 - b. Fit close and tight.
 - c. Provide a smooth and uniform interior surface.
 - d. Secure and hold adjoining sections to each other.
 - e. Fasten securely to adjoining structures and special sections.
 2. Field mortar joints shall be made in accordance with the following:
 - a. Clean and wet the surfaces to be joined with water.
 - b. Apply mortar to the lower portion of the bell or groove of the section already laid and to the upper portion of the spigot or tongue of the section being laid.
 - c. Clean the joint recesses, fill with mortar and wipe to a smooth finish both inside and out.
 - d. Do not allow free water to come in contact with mortar joints within 24 hours after the mortared joints are finished.
 - e. Protect the completed joints against rapid drying.
 3. Watertight field joints with rubber gaskets shall be used for all storm and sanitary sewers. Gaskets shall be installed in accordance with the manufacturer's installation instructions.
- E. Inspection: All pipe shall be inspected after laying and joining but before backfilling. Pipe which is out of alignment, unduly settled, or damaged shall be taken up and relayed, or replaced.
- F. Backfilling
1. Backfilling shall be as specified in Section 31 22 00.
 2. Where the top of pipe is exposed above the top of the trench, embankment layers shall be placed and compacted to above the top of Pipe Compaction Zone shown on the Contract Drawings.
 3. Heavy construction equipment shall not cross over pipes until at least 4 feet of compacted cover has been placed.
 4. Material for side fill around and to the top of box culverts shall be select crushed rock and shall not contain stones larger than 3" in greatest dimension or moisture in excess of that permitted through the compaction requirements of Section 31 22 00.

3.2 MANHOLES, CATCH BASINS AND HEADWALLS

- A. Earthwork: Excavation and backfill shall be in accordance with the requirements of Section 31 22 00 as appropriate.
- B. Cast-In-Place Concrete: Cast-in-place concrete shall be in accordance with the requirements of Sections 03 20 10 and 03 30 00.
- C. Precast Concrete: Joints shall be made in accordance with the applicable requirements specified herein for watertight pipe joints or in accordance with the manufacturer's instructions.
- D. Pipe Connections: Connecting pipes shall be placed at required alignment and grade. Pipes shall be set through the full thickness of the wall flush with inner face of the wall. Joints between pipe and wall shall be watertight.
- E. Frames, Covers, Grates, and Fittings: Metal frames shall be set on full mortar beds. If concrete is to be poured around the frames, the portion of the frame that will contact the concrete shall be painted with hot asphalt before placing the concrete. Frames, covers and grates shall be set true to the locations and grades established. Bearing surfaces shall be cleaned to provide uniform contact. All fastenings shall be secure.
- F. Manhole Steps: Manhole steps shall be installed in accordance with details referenced by plans.

3.3 TESTING

- A. Testing Storm Drain Pipe: Storm Drain Pipe shall be visually inspected for cleanliness. Water shall be discharged into all inlets to assure that lines are free of obstructions and leakage.

PART IV - MEASUREMENT

4.1 Measurement

- A. The quantities of accepted work will be measured in the following units. All measurements will be plan measure except for authorized changes.
 - 1. Curb Inlets EA (Each)
 - 2. Curb Inlets – Type 2 EA
 - 3. Rehab Manholes EA
 - 4. Remove Brick MH, New 48" MH EA
 - 5. Remove Curb Inlets EA
 - 6. Core & Grout 8" PVC into Existing/Rehab CI/MH EA
 - 7. Core & Grout 15" RCP into Existing/Rehab CI/MH EA
 - 8. Track & Bridge Drain EA

9. Raise Existing Bridge Barrier Scuppers EA
10. 8" PVC LF (Linear Foot)
11. 15" RCP LF
12. 15" HDPE LF
13. Fill Abandoned Pipe (Unknown Dia.) LF
14. Protect-in-Place Ex. 12" RCP LF

PART V - PAYMENT

5.1 Payment

Payment will be made at the respective unit or lump-sum price listed in the proposal and shall be full compensation for all labor, materials, and equipment necessary to complete the respective unit in place. There will be no separate measurement or payment for any item of work not specifically identified and listed in the proposal, and all such work shall be considered a subsidiary item with all costs pertaining thereto included in the prices for other items listed in the proposal. At the Engineer's option, partial payment may be made for any lump sum item listed in the proposal, providing that the Contractor is diligently and satisfactorily pursuing full completion of such partially complete item in accordance with the approved job progress schedule.

END OF SECTION

SECTION 33 41 13**REINFORCED CONCRETE PIPE****PART 1 - GENERAL****1.01 SCOPE OF WORK**

- A. This section covers all work, materials, and testing for installation of reinforced concrete storm sewer pipe by the open-cut method as shown on the Drawings and in conformity with these specifications. All pipelines shall be constructed to proper line and grade as shown on the Drawings and shall result in an unobstructed, smooth and uniform conduit.

1.02 DESCRIPTION

- A. Reinforced concrete pipe construction shall consist of furnishing all labor, materials and equipment for the complete installation of reinforced concrete pipe and appurtenances in accordance with Contract Drawings and these specifications and as specified in American Public Works Association Standard Specifications and Design Criteria Section 2600 as revised, adopted, and provided by the Director of Kansas City, Missouri Public Works current at the time of bidding and American Public Works Association Standard Specifications.

1.03 SPECIFICATION MODIFICATIONS

- A. It is understood that throughout this section these Specifications may be modified by appropriate items in the Specific Project Requirements section of these specifications or on the Contract Drawings.

1.04 REVISIONS OF STANDARDS

- A. In addition to complying with all pertinent codes and regulations, comply with the referenced or applicable portions of the American Public Works Association Standard Specifications and Design Criteria as revised, adopted, and provided by the director of Kansas City, Missouri Public Works current at the time of bidding.
- B. When reference is made to a Standard Specification, i.e., ASTM, ANSI, AWWA, the Specification referred to shall be understood to mean the latest revision of said specifications as amended at the time of the Notice to Bidders, except as noted on the Drawings or in the Specific Project Requirements section of these specifications.

PART 2 - PRODUCTS**2.01 MATERIALS**

- A. General - This section governs materials that may be required to complete pipeline construction, exclusive of structures, as shown on the drawings and/or as provided for in the Modifications to Detailed Specifications.
- B. Requirements - Furnish pipe materials, joint types, sizes, and strength classes indicated and specified. Higher strengths may be furnished at the Contractor's option at no additional cost to the Owner.
- C. Manufacturer - The manufacturer shall be experienced in the design, manufacture and commercial supplying of the specific material.

2.02 PIPE, FITTINGS, JOINTS, COATINGS

- A. Reinforced Concrete Pipe: Reinforced concrete pipe shall conform to the following ASTM Standards and be of the minimum strength designated herein or such higher strength as may be required by the Contract Drawings or Special Provisions:
 - 1. Round Pipe: ASTM C 76, Class III, Wall B
 - 2. Elliptical Pipe: ASTM C 507, Class HE-III
 - 3. Arch Culvert Pipe: ASTM C 506, Class A-III
- B. Joints: Flexible gaskets may be either flat gaskets cemented to the pipe tongue or spigot, O-ring gaskets, or roll-on gaskets.
 - 1. All gaskets shall conform to ASTM C 443.

2.03 GRANULAR BEDDING MATERIAL

- A. Granular bedding material shall be crushed clean limestone aggregate meeting one of the following gradations:

Bedding Material Gradation Limits, % Passing

Sieve Size	3/4"	1/2"	3/8"
1"	100		
3/4"	90-100	100	
1/2"		80-100	
3/8"	20-55	40-70	100
No. 4	0-10	0-15	30-40
No. 8	0-5	0-5	0-4

In areas where the pipe trench is below the potential high point of the water table, only three-eighths (3/8") inch bedding may be used.

2.04 FLOWABLE BACKFILL: CONTROLLED LOW STRENGTH MATERIAL (CLSM):

- A. The CLSM materials proposed for use in construction shall conform to the following requirements:
- a. Cement shall conform to ASTM C 150, Type I or Type II.
 - b. Fly Ash shall conform to ASTM C 618, Class C
 - c. Fine Aggregate shall conform to ASTM C 33.
 - d. Mixing water shall conform to ASTM C 94.
 - e. Admixtures shall only be used when specified by the Engineer.
- B. Mixture Design
- a. The CLSM Flowable Backfill shall be transit mix, or from a mobile mixer. The elapsed time from when the water is added for batching until the CLSM is placed shall not exceed two hours.
 - b. The slurry mixture shall be mixed between 70 to 100 revolutions of the ready-mixed truck. To minimize segregation, all flowable fill material shall be re-mixed at the project site at mixing speed in the ready-mix truck for approximately two (2) minutes immediately prior to discharge of the slurry mixture.
 - c. The CLSM shall be composed of the proportions as hereinafter provided, or an acceptable mix as approved by the Engineer.

Design Mix	Type A	Type B	Type C
Type 1 Cement	150 lbs.	50 lbs.	0 lbs.
Water	460 (55 gal.)	500 (60 gal.)	542 (65 gal.)
Sand	3085 lbs.	2817 lbs.	2649 lbs.
Class C Fly Ash	0 lb.	250 lbs.	350 lbs.

PART 3 - EXECUTION

3.01 HANDLING AND PROTECTION

- A. Pipe and accessories shall be handled in a manner that will ensure their installation in the work in a sound, undamaged condition. Equipment, tools and methods used in unloading, reloading, hauling and laying pipe and fittings shall be such that the pipe is not damaged. Pipe having premolded joints shall be handled in such a manner that no weight, including the weight of the pipe itself, will bear on or be supported by the spigot end or bell end at any time. Pipe and pipe fittings which have been

damaged in any way will not be accepted and shall be removed from the project site.

- B. All pipe shall be protected during installation against shock and free fall, and be installed without cracking, chipping, breaking, bending, or damage to coating materials. Damaged pipe materials shall be replaced with new materials except as may be permitted by the Engineer.

3.02 CUTTING PIPE

- A. Cutting of pipe shall be done in a neat manner, without damage to the pipe. Pipe cuts shall be smooth, straight and at right angles to the pipe axis. All cutting of pipe shall be done with mechanical pipe cutters of an approved type except that in locations where the use of mechanical cutters would be impracticable, existing pipe may be cut with diamond point chisels, saws, or other tools which will cut the pipe without a damaging impact or shock.

3.03 CLEANING

- A. The interior of all pipe shall be cleaned of all foreign matter before being installed and shall be kept clean until the work has been accepted. All lumps, blisters and excess coating shall be removed from exterior spigot and interior bell surfaces. Such surfaces shall be wired brushed and wiped clean, dry, and free from oil and grease before placing the spigot in the bell. All joint contact surfaces shall be kept clean until the jointing is completed.
- B. Every precaution shall be taken to prevent foreign material from entering the pipe while it is being installed. No debris, tools, clothing, or other materials shall be placed in the pipe.
- C. Whenever pipe laying is stopped at the end of the work day, the open end of the line shall be sealed with a watertight plug. Whenever a tie-in to the existing collection system is made, a plug shall be installed in the new line to prevent water and/or debris from entering the existing collection system.

3.04 INSPECTION

- A. Pipe and fittings shall be carefully examined for cracks and other defects immediately before installation; spigot ends shall be examined with particular care. All defective pipe and fittings shall be marked as such and removed from the site of the work.

3.05 TRENCH EXCAVATION

- A. Prior to excavation of the sewer trench in any fill areas, fill shall be compacted to a minimum 90% of maximum density (as determined by ASTM D 698) up to a minimum height of 18 inches above the top of the

proposed pipe. Trenches shall be excavated to the width and depth as necessary to lay the sewer pipe to the grade line as indicated on the Contract Drawings. Deviation from the indicated alignment will not be permitted except under special circumstances, subject to approval of the Engineer. Excavated materials are to be deposited beside trenches and excavations, beyond the reach of slides, transported to the spoil banks, or used for backfilling.

- B. The length of trench excavation opened at one time shall be limited depending on the nature of the soil or other safety considerations. Trenches shall be excavated to a width that will provide adequate working space and pipe clearances for proper pipe installation, jointing, and embedment. However, the limiting trench widths must comply with the bedding class requirements set forth in APWA Section 2602.3.C. Over-excavation shall be replaced with granular bedding material, or CLSM.
- 1 **Unclassified Excavation:** Unclassified excavation is defined as the removal of all material encountered regardless of its nature. All material excavated will be considered as Unclassified Excavation.
 - 2 **De-watering:** The Contractor shall remove any water that may accumulate, or be found in the trenches and other excavations made under the Contract. The Contractor shall form all dams, flumes or other works necessary to keep them clear of water while the sewers and their foundations, and other foundation works, are being constructed. All water shall be removed from such excavation in a manner to avoid damage to property.
 - 3 **Cribbing and Sheeting:** The Contractor shall furnish, install, and maintain such sheeting, bracing, and other components, as may be required to support any excavation and to prevent any movement which could in any way injure or delay the work or endanger adjacent pavement, building, or other structures. Care shall be taken to prevent voids outside of the sheeting, but if voids are formed they shall be immediately filled and consolidated.
 - 4 **Unstable Foundation:** Where materials encountered in the bottom of the trench are deemed as unsuitable by the Engineer to afford a sufficiently stable pipe foundation, the materials shall be removed to the depth and limits as ordered by the Engineer. Areas undergraded shall be backfilled with approved granular material.
 - 5 **Protection of Property:** The Contractor shall satisfactorily shore, support, and protect any and all structures and all pipes, sewers, drains, conduits, and other facilities, and shall be responsible for any damage resulting thereto. The Contractor shall not be entitled to any damages or extra pay on account of any postponement, interference, or delay caused by any such structures and facilities being on the line of work, whether or not they are shown on the Contract Drawings;

specifically, but not limited to, damage due to delay in utility relocation.

3.06 ALIGNMENT AND GRADE

- A. All pipe shall be laid straight between changes in alignment and at a uniform grade between changes in grade. All lines shall be laid so that each section between structures will lamp.
- B. Maximum deviation from indicated alignment of any pipe after installation and backfilling shall not be greater than 0.1 foot. All pipe shall have a continuous slope free from depressions that will not drain. The Contractor shall establish such grade control devices as are necessary to maintain the above tolerances.

3.07 LAYING AND JOINTING PIPE

- A. Handling and Protection: All pipe shall be protected during installation against shock and free fall, and be installed without cracking, chipping, breaking, bending, or damage to coating materials. Damaged pipe materials shall be replaced with new materials except as may be permitted by the Engineer.
- B. Grade Control: Maximum deviation from indicated alignment of any pipe after installation and backfilling shall not be greater than 0.1 foot. All pipe shall have a continuous slope free from depressions that will not drain. The Contractor shall establish such grade control devices as are necessary to maintain the above tolerances.
- C. Laying: The laying of pipe in finished trenches shall commence at the lowest point, and pipe shall be installed with the bell end forward or upgrade. All pipe shall be laid with ends abutting and true to line and grade. Pipe shall be carefully centered to form a sewer with a uniform invert.
- D. Bedding: The class of bedding required shall be as indicated on the Contract Drawings or standard details except that as a minimum the bedding shall be granular bedding material placed to the requirements of APWA Section 2602.3.C titled "Backfill of Trenches." Bedding shall be rodded, spaded, and consolidated as necessary to provide firm uniform support for the pipe, and not subject pipe to settlement or displacement.
- E. Jointing: Preparatory to making filled, bonded, and watertight sealed pipe joints, all surfaces of the portions of the pipe to be jointed shall be clean and dry. Lubricants, primers, adhesives, and other substances that are used shall be compatible with the jointing material recommended or specified.
 - 1. Other than for trimming sewer pipe to be flush with the inside walls of storm sewer structures, no pipes may be trimmed unless ordered by

the Engineer. Pipes having defects that do not cause their rejection shall be so laid as to place these defects where they will be of least consequence.

2. Trenches shall be kept water-free and as dry as possible during bedding, laying, and jointing, and for as long a period as required to protect the pipe joints and concrete in structures.
3. As soon as possible after the joint is made, sufficient bedding material shall be placed alongside each side of the pipe to offset conditions that might tend to move the pipe off line and grade.
4. Concrete Pipe Flexible Gaskets: Flat gaskets may be cemented to the pipe tongue or spigot. O-ring gaskets shall be recessed in a groove on the tongue or spigot and confined by the bell or groove after the joint is completed. Roll-on gaskets shall be placed around the tongue or spigot and rolled into position as the joint is assembled. Flat gaskets and O-ring gaskets shall be lubricated as recommended by the manufacturer.
 - i. Flat gasket: Flat flexible gaskets shall conform to ASTM C 443. If there is no recess provided for the gasket, the surface of the tongue shall be cleaned and rubber adhesive applied. Using quick-drying adhesive, gaskets may be applied ahead of the laying operation or in the plant.
 - ii. O-ring gasket: O-ring or roll-on flexible gaskets shall conform to ASTM C 361, Section 4.10. The entire surface of the bell that comes in contact with the rubber gasket shall be well lubricated with a soap lubricant. The entire gasket shall be greased with soap. Only the soap lubricant supplied by the pipe manufacturer shall be used. Adhesive type cements shall not be used.
5. Structure Connections: Pipes connected to structures shall be cut parallel with the inside face of the structures. Projection of the pipe beyond the inside face shall not exceed 1 inch (measured at the springline for structures having curved walls.)

3.08 PIPE EMBEDMENT AND TRENCH BACKFILL

A. Pipe Embedment

1. As soon as possible after the joint is made, sufficient bedding material shall be placed alongside each side of the pipe to offset conditions that might tend to move the pipe off line and grade.
2. The class of bedding required shall be as indicated on the Contract Drawings or standard details.

3. Bedding shall be rodded, spaded, and consolidated as necessary to provide firm uniform support for the pipe, and not subject pipe to settlement or displacement.

B. Pipe Backfill

1. Pipe backfill shall be as indicated on the Contract Drawings or standard details.
2. The CLSM shall be constructed to the configuration and the lines and grades shown on the Contract Drawings, or as directed by the Engineer.
3. No CLSM shall be placed on frozen ground. When the ambient temperature either falls or is forecasted to fall below 35 degrees F within 24 hours of its proposed placement time, a set accelerator shall be used.

END OF SECTION 33 41 13

SECTION 33 41 14**HDPE STORM SEWER PIPE****PART 1 - GENERAL****1.01 SCOPE OF WORK**

- A. This section covers all work, materials, and testing for installation of HDPE storm sewer pipe by the open-cut method as shown on the Drawings and in conformity with these specifications. All pipelines shall be constructed to proper line and grade as shown on the Drawings and shall result in an unobstructed, smooth and uniform conduit.

1.02 DESCRIPTION

- A. Storm sewer construction shall consist of furnishing all labor, materials and equipment for the complete installation of HDPE storm sewer pipe and appurtenances in accordance with Contract Drawings and these specifications and as specified in American Public Works Association Standard Specifications and Design Criteria Section 2600 titled "Storm Sewers" as revised, adopted, and provided by the director of Kansas City, Missouri Public Works current at the time of bidding and American Public Works Association Standard Specifications.

1.03 SPECIFICATION MODIFICATIONS

- A. It is understood that throughout this section these Specifications may be modified by appropriate items in the Specific Project Requirements section of these specifications or on the Contract Drawings.

1.04 REVISIONS OF STANDARDS

- A. In addition to complying with all pertinent codes and regulations, comply with the referenced or applicable portions of the American Public Works Association Standard Specifications and Design Criteria as revised, adopted, and provided by the Director of Kansas City, Missouri Public Works current at the time of bidding.
- B. When reference is made to a Standard Specification, i.e., ASTM, ANSI, AWWA, the Specification referred to shall be understood to mean the latest revision of said specifications as amended at the time of the Notice to Bidders, except as noted on the Drawings or in the Specific Project Requirements section of these specifications.

PART 2 - PRODUCTS**2.01 MATERIALS**

- A. General - This section governs materials that may be required to complete pipeline construction, exclusive of structures, as shown on the drawings and/or as provided for in the Modifications to Detailed Specifications.
- B. Requirements - Furnish pipe materials, joint types, sizes, and strength classes indicated and specified. Higher strengths may be furnished at the Contractor's option at no additional cost to the Owner.
- C. Manufacturer - The manufacturer shall be experienced in the design, manufacture and commercial supplying of the specific material.
- D. Inspection and Testing – Installation shall be witnessed by Owner, Engineer, or approved independent testing laboratory. The contractor shall provide certified test reports indicating that materials conform to these specifications.

2.02 PIPE, FITTINGS, JOINTS, COATINGS

- A. High Density Polyethylene Pipe: High density polyethylene (HDPE) pipe and fittings shall conform to ASTM F2306 with annual corrugations and an integral bell and spigot. The manufacturer of the pipe must participate in the AASHTO/National Transportation Product Evaluation Program (NTPEP). The maximum cover depth shall be 30 feet.
 - 1. Materials: Virgin material for pipe and fitting production shall be HDPE conforming with the minimum requirements of cell classification 435400C for 12" to 60" diameters as defined in ASTM D3350, except carbon black content shall not exceed 4%
 - 2. Joints: Joint tightness shall conform to ASTM D3212. Elastomeric seal (gasket) shall have a basic polymer of synthetic rubber conforming to ASTM F477. Natural rubber gaskets will not be used. Bells shall span over three corrugations.
 - 3. General Description. Furnish maximum pipe length normally produced by the manufacturer except for fittings, closures and specials.

2.03 GRANULAR BEDDING MATERIAL

- A. Granular bedding material shall be crushed clean limestone aggregate meeting one of the following gradations:

Bedding Material Gradation Limits, % Passing

Sieve Size	3/4"	1/2"	3/8"
1"	100		
3/4"	90-100	100	
1/2"		80-100	
3/8"	20-55	40-70	100
No. 4	0-10	0-15	30-40
No. 8	0-5	0-5	0-4

In areas where the pipe trench is below the potential high point of the water table, only three-eighths (3/8") inch bedding may be used.

2.04 FLOWABLE BACKFILL: CONTROLLED LOW STRENGTH MATERIAL (CLSM):

A. The CLSM materials proposed for use in construction shall conform to the following requirements:

- a. Cement shall conform to ASTM C 150, Type I or Type II.
- b. Fly Ash shall conform to ASTM C 618, Class C
- c. Fine Aggregate shall conform to ASTM C 33.
- d. Mixing water shall conform to ASTM C 94.
- e. Admixtures shall only be used when specified by the Engineer.

B. Mixture Design

- a. The CLSM Flowable Backfill shall be transit mix, or from a mobile mixer. The elapsed time from when the water is added for batching until the CLSM is placed shall not exceed two hours.
- b. The slurry mixture shall be mixed between 70 to 100 revolutions of the ready-mixed truck. To minimize segregation, all flowable fill material shall be re-mixed at the project site at mixing speed in the ready-mix truck for approximately two (2) minutes immediately prior to discharge of the slurry mixture.
- c. The CLSM shall be composed of the proportions as hereinafter provided, or an acceptable mix as approved by the Engineer.

Design Mix	Type A	Type B	Type C
Type 1 Cement	150 lbs.	50 lbs.	0 lbs.
Water	460 (55 gal.)	500 (60 gal.)	542 (65 gal.)
Sand	3085 lbs.	2817 lbs.	2649 lbs.
Class C Fly Ash	0 lb.	250 lbs.	350 lbs.

PART 3 - EXECUTION**3.01 HANDLING AND PROTECTION**

- A. Pipe and accessories shall be handled in a manner that will ensure their installation in the work in a sound, undamaged condition. Equipment, tools and methods used in unloading, reloading, hauling and laying pipe and fittings shall be such that the pipe is not damaged. Pipe having premolded joints shall be handled in such a manner that no weight, including the weight of the pipe itself, will bear on or be supported by the spigot end or bell end at any time. Pipe and pipe fittings which have been damaged in any way will not be accepted and shall be removed from the project site.
- B. All pipe shall be protected during installation against shock and free fall, and be installed without cracking, chipping, breaking, bending, or damage to coating materials. Damaged pipe materials shall be replaced with new materials except as may be permitted by the Engineer.

3.02 LAYING PIPE

- A. Pipe shall be protected from lateral displacement by means of pipe embedment material installed as provided in Section 32 11 00. Under no circumstances shall pipe be laid in water and no pipe shall be laid under unsuitable weather or trench conditions.
- B. When jointed in the trench, the pipe shall form a true and smooth line. Pipe shall not be trimmed except for closures, and pipe not making a good fit shall be removed.
- C. Pipe which is part of a storm sewer line shall be aligned and constructed to grades as shown on the Drawings.
- D. The laying of pipe in finished trenches shall commence at the lowest point, and pipe shall be installed with the bell end forward or upgrade. All pipe shall be laid with ends abutting and true to line and grade. Pipe shall be carefully centered to form a sewer with a uniform invert.
- E. HDPE Pipe: HDPE pipe shall be assembled and installed in accordance with the manufacturer's instructions. For pipe sizes 48 inches and larger, during pipe installation, including placement and consolidation of the rock bedding and backfill to a point 4 feet above the top of the pipe, full time inspection shall be provided by a qualified inspector working under the supervision of a professional engineer.
- F. During construction of the project in areas subjected to heavy construction equipment traffic, pipe sizes 12" – 42" shall have a minimum cover of 3 feet, and pipe sizes 48"-120" shall have a minimum cover of 4 feet. Full time inspection for this fill shall be provided by a

qualified inspector working under the supervision of a professional engineer who is registered in the State of Missouri.

- G. Structure Connections: Pipes connected to structures shall be cut parallel with the inside face of the structures. Projection of the pipe beyond the inside face shall not exceed 1 inch (measured at the springline for structures having curved walls.)

3.03 ALIGNMENT AND GRADE

- A. All pipe shall be laid straight between changes in alignment and at a uniform grade between changes in grade. All lines shall be laid so that each section between structures will lamp.
- B. Maximum deviation from indicated alignment of any pipe after installation and backfilling shall not be greater than 0.1 foot. All pipe shall have a continuous slope free from depressions that will not drain. The Contractor shall establish such grade control devices as are necessary to maintain the above tolerances.

3.04 JOINTING

- A. Preparatory to making filled, bonded, and watertight sealed pipe joints, all surfaces of the portions of the pipe to be jointed shall be clean and dry. Lubricants, primers, adhesives, and other substances that are used shall be compatible with the jointing material recommended or specified.
- B. Other than for trimming sewer pipe to be flush with the inside walls of storm sewer structures, no pipes may be trimmed unless ordered by the Engineer. Pipes having defects that do not cause their rejection shall be so laid as to place these defects where they will be of least consequence.
- C. Trenches shall be kept water-free and as dry as possible during bedding, laying, and jointing, and for as long a period as required to protect the pipe joints and concrete in structures.
- D. As soon as possible after the joint is made, sufficient bedding material shall be placed alongside each side of the pipe to offset conditions that might tend to move the pipe off line and grade.
- E. Push-on gasketed joints. All instructions and recommendations of the pipe manufacturer, relative to gasket installation and other jointing operations, shall be observed and followed by the Contractor.

3.05 CUTTING PIPE

- A. Cutting of pipe shall be done in a neat manner, without damage to the pipe. Pipe cuts shall be smooth, straight and at right angles to the pipe axis. All cutting of pipe shall be done with mechanical pipe cutters of an approved type except that in locations where the use of mechanical cutters would be impracticable, existing pipe may be cut with diamond point chisels, saws, or other tools which will cut the pipe without a damaging impact or shock.

3.06 CLEANING

- A. The interior of all pipe shall be cleaned of all foreign matter before being installed and shall be kept clean until the work has been accepted. All lumps, blisters and excess coating shall be removed from exterior spigot and interior bell surfaces. Such surfaces shall be wired brushed and wiped clean, dry, and free from oil and grease before placing the spigot in the bell. All joint contact surfaces shall be kept clean until the jointing is completed.
- B. Every precaution shall be taken to prevent foreign material from entering the pipe while it is being installed. No debris, tools, clothing, or other materials shall be placed in the pipe.
- C. Whenever pipe laying is stopped at the end of the work day, the open end of the line shall be sealed with a watertight plug. Whenever a tie-in to the existing collection system is made, a plug shall be installed in the new line to prevent water and/or debris from entering the existing collection system.

3.07 PIPE EMBEDMENT AND TRENCH BACKFILL

- A. The class of bedding required shall be as indicated on the Contract Drawings or standard details.
- B. Bedding shall be rodded, spaded, and consolidated as necessary to provide firm uniform support for the pipe, and not subject pipe to settlement or displacement.
- C. The CLSM shall be constructed to the configuration and the lines and grades shown on the Contract Drawings, or as directed by the Engineer.
- D. No CLSM shall be placed on frozen ground. When the ambient temperature either falls or is forecasted to fall below 35 degrees F within 24 hours of its proposed placement time, a set accelerator shall be used.

END OF SECTION 33 41 14

SECTION 33 44 19**UTILITY STORM WATER TREATMENT
INFILTRATION TRENCH**

PART 1 - GENERAL

1.01 DEFINITION

- A. An infiltration trench may not receive run-off until the entire contributing drainage area to the infiltration trench has received final stabilization.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.01 SCOPE

- A. Heavy equipment and traffic shall be restricted from traveling over the proposed location of the infiltration trench to minimize compaction of the soil.
- B. Excavate the infiltration trench to the design dimensions. Excavated materials shall be placed away from the trench sides to enhance trench wall stability. Large tree roots must be trimmed flush with the trench sides in order to prevent fabric puncturing or tearing of the filter fabric during subsequent installation procedures. The side walls of the trench shall be roughened where sheared and sealed by heavy equipment.
- C. A Class "C" geotextile or better (see Section 24.0, Material Specifications, 1994 Standards and Specifications for Soil Erosion and Sediment Control, MDE, 1994) shall interface between the trench side walls and between the stone reservoir and gravel filter layers. A partial list of non-woven filter fabrics that meet the Class "C" criteria follows. Any alternative filter fabric must be approved by the plan approval authority.
 - 1. Amoco 4552 Carthage FX-80S
 - 2. GEOLON N70 Mirafi 180-N
 - 3. WEBTEC N07
- D. The width of the geotextile must include sufficient material to conform to trench perimeter irregularities and for a 6-inch minimum top overlap. The filter fabric shall be tucked under the sand layer on the bottom of the infiltration trench for a distance of 6 to 12 inches. Stones or other anchoring objects should be placed on the fabric at the edge of the trench to keep the trench open during windy periods. When overlaps are required between rolls, the uphill roll should lap a minimum of 2 feet over the downhill roll in order to provide a shingled effect.

- E. If a 6 inch sand filter layer is placed on the bottom of the infiltration trench, the sand for the infiltration trench shall be washed and meet AASHTO-M-43, Size No. 9 or No. 10.
- F. Any alternative sand gradation must be approved by the plan approval authority.
- G. The stone aggregate should be placed in a maximum loose lift thickness of 12 inches. The gravel (rounded "bank run" gravel is preferred) for the infiltration trench shall be washed and meet one of the following AASHTO-M-43, Size No. 2 or No. 3.
- H. Following the stone aggregate placement, the filter fabric shall be folded over the stone aggregate to form a 6-inch minimum longitudinal lap. The desired fill soil or stone aggregate shall be placed over the lap at sufficient intervals to maintain the lap during subsequent backfilling.
- I. Care shall be exercised to prevent natural or fill soils from intermixing with the stone aggregate. All contaminated stone aggregate shall be removed and replaced with uncontaminated stone aggregate.
- J. Voids may occur between the fabric and the excavation sides shall be avoided. Removing boulders or other obstacles from the trench walls is one source of such voids. Therefore, natural soils should be placed in these voids at the most convenient time during construction to ensure fabric conformity to the excavation sides.
- K. Vertically excavated walls may be difficult to maintain in areas where soil moisture is high or where soft cohesive or cohesionless soils are dominant. These conditions may require laying back of the side slopes to maintain stability.
- L. PVC distribution pipes shall be Schedule 40 and meet ASTM-D-1785. All fittings shall meet ASTM-D-2729. Perforations shall be 3/8 inch in diameter. A perforated pipe shall be provided only within the infiltration trench and shall terminate 1 foot short of the infiltration trench wall. The end of the PVC pipe shall be capped. Note: PVC pipe with a wall thickness classification of SDR-35 meeting ASTM-D-3034 is an acceptable substitute for the Schedule 40 pipe.
- M. The observation well is to consist of 6-inch diameter perforated PVC Schedule 40 pipe (M 278 OR F758, Type PS 28) with a cap set 6 inches above ground level and is to be located near the longitudinal center of the infiltration trench. The pipe shall have a plastic collar with ribs to prevent rotation when removing the cap. The screw top lid shall be a cleanout with a locking mechanism or special bolt to discourage vandalism. The depth to the invert shall be marked on the lid. The pipe shall be placed vertically within the gravel portion of the infiltration trench and a cap provided at the bottom of the pipe. The bottom of the cap shall rest on the infiltration trench bottom.
- N. Corrugated metal distribution pipes shall conform to AASHTO-M-36, and shall be aluminized in accordance with AASHTO-M-274. Aluminized pipe in contact with concrete shall be coated with an inert compound capable of preventing the deleterious effect of the aluminum on the concrete. Perforated distribution pipes

- shall conform to AASHTO-M-36, Class 2 and shall be provided only within the infiltration trench and shall terminate 1 foot short of the infiltration trench wall. An aluminized metal plate shall be welded to the end of the pipe.
- O. If a distribution structure with a wet well is used, a 4-inch drain pipe shall be provided at opposite ends of the infiltration trench distribution structure. Two (2) cubic feet of porous backfill meeting AASHTO-M-43, Size No. 57 shall be provided at each drain.
 - P. If a distribution structure is used, the manhole cover shall be bolted to the frame.

END OF SECTION 33 44 19

SECTION 33 44 19.16**CATCH BASIN INSERT UTILITY STORM WATER FILTER
CONTECH TRITON DROP-IN MODEL OR APPROVED EQUAL****PART 1 - GENERAL****1.01 DESCRIPTION****A. Work included:**

The Contractor, and/or a manufacturer selected by the Contractor and approved by the Engineer, shall furnish all labor, materials, equipment and incidentals required and install all catch basin inserts in accordance with the drawings and these specifications.

B. The Triton Drop Inlet system is designed for use in stormdrains that experience oil and grease pollution accompanied by sediment, trash and debris. Trash, debris and sediment accumulate in the outer housing with oil and grease and fine particulates being trapped in the media cartridge. The system is a low cost best management practice (BMP) that helps meet National Pollutant Discharge Elimination System (NPDES) requirements with effective treatment, efficient installation and moderate maintenance.

1.02 QUALITY CONTROL INSPECTION

A. The quality of materials, the process of manufacture, and the finished sections shall be subject to inspection by the Engineer. Such inspection may be made at the place of manufacture, or on the work site after delivery, or at both places, and the sections shall be subject to rejection at any time if material conditions fail to meet any of the specification requirements, even though sample sections may have been accepted as satisfactory at the place of manufacture. Sections rejected after delivery to the site shall be marked for identification and shall be removed from the site at once. All sections that have been damaged beyond repair during delivery will be rejected and, if already installed, shall be repaired to the Engineer's acceptance level, if permitted, or removed and replaced, entirely at the Contractor's expense.

PART 2 - PRODUCTS**2.01 MATERIALS AND DESIGN****A. Insert Trough/Housing**

1. Inserts are available to fit most industry standard catch basins. Custom sizes are available to fit most applications.
2. Standard insert troughs or housings shall be constructed of non-reactive high density polyethylene (HDPE) plastic with U.V. inhibitors. Larger units requiring greater structural support shall be constructed

using fiberglass with Isophthalic polyester resin, which provides corrosion resistance needed for wet applications.

B. Exterior Cartridge Cage

1. The exterior cage of the cartridges shall be made of stainless steel Type 304, having 0.063 gauge welded 1" square openings.

C. Media-Pak Cartridges

1. Disposable media-pak cartridges shall be constructed of durable geotextile polyethylene fabric.
2. Media-pak cartridges shall be easily removed from housing for maintenance.

D. Media and Media-Pak Combinations

1. A number of combinations can be set in place to obtain the most appropriate treatment level for the site.

Option A – Standard: Includes media-pak (a durable geotextile polypropylene fabric) charged with XSORB® media for capture of hydrocarbons, oils and grease and sediment.

Option B – Standard setup with cartridge pre-screen: Includes exterior cartridge housing fitted with a woven polypropylene geo-textile that is designed to capture smaller sediment (e.g., 850 microns).

Option C – Dual stage media-pak charged with XSORB® media: Includes two media-pak staggered within a cartridge cage designed to target heavy hydrocarbon runoff areas.

Option D – Dual stage media-pak with activated carbon: A standard media-pak is fitted on the outer interior of the cartridge housing with a second media-pak (charged with activated carbon) fitted behind the standard media-pak. The second media-pak is designed as a polishing media to remove pollutants found in runoff.

2. The media shall be non-biodegradable and non-hazardous per the Environmental Protection Agency (EPA) and Occupational Safety and Health Administration (OSHA).

3. Media shall be a treated perlite having hydrophobic properties.

E. Diverter Panels

1. If required, diverter panels or flow block material shall be ultra violet resistant high density polyethylene.

2.02 PERFORMANCE

Each standard Triton Drop Inlet model shall adhere to the following performance specifications.

Drop Inlet Model No.	Flange Outside Dimension (OD)	Trash and Debris Capacity (ft ³)	Treatment Capacity ₁ (gpm)	Bypass Capacity* (gpm)
TR12RD	13"	0.193	70	830
TR1212	13"X13"	0.193	70	830
TR 16RD	18"	0.673	142	1,660
TR1616	18"X18"	0.673	142	1,660
TR18RD	20"	0.936	151	1,660
TR1818	20"X20"	0.936	151	3,103
TR1824	19"X25"	0.936	157	3,103
TR2024	21"X25"	0.936	157	3,103
TR24RD	26"	1.070	299	4,261
TR24SR	26"X26"	1.070	299	4,261
TR2436	26"X40"	1.570	345	6,206
TR2448	26"X52"	2.140	572	8,522
TR3030	33"X33"	1.570	345	6,206
TR3636	40"X40"	8,430	690	12,412
TR36RD	40"	8,430	690	12,412
TR4848	52"X52"	15.500	1,196	17,044

* Bypass Capacity is estimated as circular weir flow and is a function of the available head (inside top of structure to the overflow crest of the cartridge) and crest length. Typically, the bypass capacity should be less restrictive than the inlet grate of the catch basin.

1 – Treatment capacity based on standard media-pak configuration (Option A).

2.03 MANUFACTURER

The manufacturer of said system shall have been regularly engaged in the engineering design and production of systems for the physical treatment of stormwater runoff for 10 years minimum. Each catch basin insert shall be supplied by CONTECH Stormwater Solutions Inc., 9025 Centre Pointe Drive, Suite 400, West Chester, OH 45069, phone 1-866-551-8325 or approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Each stormwater treatment system shall be constructed according to the dimensions shown on the Drawings and as specified herein. Install at elevations and locations shown on the Drawings or as otherwise directed by the Engineer.

B. If required in most cases, the housing flange can be cut in the field using a skillsaw or other saw blade to fit the grate frame.

END OF SECTION 33 44 19 16 - 3

SECTION 33 46 00**SUBDRAINAGE****PART I - GENERAL****1.1 SUMMARY****A. Description**

This Section covers the furnishing and installation of perforated track subdrain pipe, fittings, cleanouts, non-perforated pipe laterals, ditch catch basins, geotextile fabric and drain rock as shown on the Contract Drawings and specified herein.

B. Related Sections

1. 31 23 33 – Trenching, Backfilling and Compacting for Utilities
2. 31 05 19.13 – Geotextiles for Earthwork
3. 03 30 00 - Cast-In-Place Concrete
4. 33 40 00 – Storm Drainage Utilities

1.2 REFERENCES

<u>Sponsor</u>	<u>Number</u>	<u>Subject</u>
AASHTO	M 252	Corrugated Polyethylene Drainage Tubing 3" - 10" Diameter
AASHTO	M 294	Corrugated Polyethylene Drainage Pipe 12" - 24" Diameter
AASHTO	M 36	Corrugated Steel Pipe, Metallic –Coated, for Sewers and Drains
AASHTO	M 245	Corrugated Steel Pipe, Polymer Precoated, for Sewers and Drains
ASTM	C 136	Gradation by sieve analysis
ASTM	A 48	Gray Iron Castings
ASTM	D 2419	Sand Equivalent
ASTM	D 2729	Standard Specification for Poly (vinyl chloride) (PVC) Sewer Pipe and Fittings
ASTM	F 667	Corrugated Polyethylene Pipe, 8" - 24" Diameter

1.3 SUBMITTALS

- A. Submittals shall be made in accordance with the requirements of the Project Quality Plan, except as modified herein.
- B. Manufacturer's data sheet for pipe and fitting material, details of precast Ditch Catch Basins, details of metal components for frame and grates.
- C. Certificate of compliance with the gradation requirements for the drain rock included in this Section.

PART II - PRODUCTS**2.1 MATERIALS**

- A. Drain Rock and Filter Fabric
 - 1. Drain rock shall be specially graded or crushed material that meets the following requirements:

<u>Sieve Size</u>	<u>Percentages Passing by Weight</u>
2 Inch	100
1-1/2 Inch	30 - 65
3/4 Inch	0 - 5
No. 100	0 - 2
 - 2. Sieve analysis will be determined according to ASTM C 136. Sand equivalent will be tested according to ASTM D 2419 and shall not be less than 25.
 - 3. Filter fabric shall conform to standards in Section 31 05 19.13.
- B. Perforated Underdrain Pipe (HDPE) and Fittings
 - 1. Corrugated polyethylene pipe tubing and fittings shall conform to ASTM F 667, M294, and AASHTO M 252. Perforated pipe shall be circumferentially perforated.
 - 2. PVC pipe and fittings shall conform to the requirements of ASTM D2729.
 - 3. Only one type pipe material to be used throughout the project.
 - 4. Strength of pipe shall support E-80 loads under 24 inches minimum cover (top of pipe to bottom of rail).
- C. Pipe (non-peforated laterals)
 - 1. Lateral pipes shall be HDPE or galvanized corrugated metal pipe.
 - 2. Strength of lateral pipe shall support E-80 loads under 24 inches minimum cover (top of pipe to bottom of rail).
 - 3. Corrugated metal pipe shall be galvanized and shall meet AREMA Manual for Railway Engineering Table 1-4-29. Corrugations shall be 2 2/3 inches by 1/2 inches and 0.064 inch thickness (16 gage).

4. HDPE laterals shall conform to Section 2.1.B except laterals do not have perforations.
- D. Cleanout frame and grate shall conform to ASTM A48.

PART III - EXECUTION

3.1 FIELD OPERATION

- A. Trenching shall conform to Section 31 23 33.
- B. Preparation of Trench Bottom
1. The trench bottom shall be excavated to a grade one-half the outer diameter of the underdrain pipe below bottom of pipe.
 2. Filter fabric shall be placed in the bottom of the trench as specified in Section 31 05 19.13 and shown on the Contract Drawings.
 3. The trench bottom shall then be refilled to the bottom of pipe grade with approved drain rock to ensure complete and continuous support for the barrel of the pipe.
 4. Bell holes shall be excavated.
- C. Placement
1. Pipes shall be laid in the upstream direction per the Contract Drawings, with the bell point upgrade. Perforated pipes shall be placed with slots or perforations down.
 2. Interior surfaces of pipes shall be kept clean during placement. Pipe ends shall be blocked to prevent drain rock from entering the pipes.
 3. Filter fabric shall completely enclose the drain rock and be lapped as shown on the Contract Drawings.
 4. After pipe is laid and joined, prior to backfilling, the installation will be inspected. Any pipe found to be out of alignment, unduly settled or damaged shall be taken up and relayed or replaced.
- D. Ditch Catch Basins shall be provided on the track underdrain system as indicated on the Contract Drawings.
- E. Drain rock for bedding shall be placed uniformly and equally along each side of the pipe in layers not exceeding six inches after compaction. Each layer shall be spaded to eliminate voids.
- F. Compact top of trench with one pass of a vibratory roller to eliminate voids.
- G. Filter fabric shall be lapped in accordance with Section 31 05 19.13 and shall be securely joined to the junction structure.
- H. Field Inspection

1. Pipes and accessories shall be inspected for defects before lowering into the trenches.
2. Defective, damaged or unsatisfactory pipes and accessories shall be replaced.

PART IV - MEASUREMENT

4.1 Measurement

- A. The quantities of accepted work will be measured in the following units. All measurements will be plan measure except for authorized changes.
 1. Underdrain, 4" Perforated LF (Linear Foot)
 2. Underdrain Tie In To Drainage EA (Each)

PART V - PAYMENT

5.1 Payment

Payment will be made at the respective unit or lump-sum price listed in the proposal and shall be full compensation for all labor, materials, and equipment necessary to complete the respective unit in place. There will be no separate measurement or payment for any item of work not specifically identified and listed in the proposal, and all such work shall be considered a subsidiary item with all costs pertaining thereto included in the prices for other items listed in the proposal. At the Engineer's option, partial payment may be made for any lump sum item listed in the proposal, providing that the Contractor is diligently and satisfactorily pursuing full completion of such partially complete item in accordance with the approved job progress schedule.

END OF SECTION

SECTION 33 46 16.19**UNDERDRAINS**

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. Underdrain construction shall consist of furnishing of all labor, equipment and materials necessary for the complete installation of underdrains, including pipe, geotextiles and granular filter material in accordance with these specifications, standard drawings, the contract special provisions, and as shown on the Plans or established by the Engineer.

1.02 RELATED WORK

- A. Submittals are included in Section 01 33 00.
- B. Site preparation is included in Section 31 22 00 Site Preparation and Grading.
- C. Subgrade Preparation is included in Section 31 23 13 Subgrade Preparation.
- D. Crushed Aggregate Base Course is included in APWA Section 02203 Incidental Construction.
- E. Portland cement concrete paving is included in Section 32 13 13.

1.03 REFERENCE STANDARDS

- A. In addition to complying with all pertinent codes and regulations, comply with the referenced or applicable portions of the American Public Works Association Design Criteria and Standard Specifications as revised, adopted, and provided by the Director of Kansas City, Missouri Public Works current at the time of bidding.
- B. American Society for Testing and Materials (ASTM)
 - 1. ASTM C33 - Standard Specification for Concrete Aggregates
 - 2. ASTM C88 – Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
 - 3. ASTM C131 – Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
 - 4. ASTM C136 – Test Method for Sieve Analysis of Fine and Coarse Aggregates

5. ASTM C142 – Test Method for Clay Lumps and Friable Particles in Aggregates
 6. ASTM D75 – Practice for Sampling Aggregates
 7. ASTM D422 – Test Method for Particle Size Analysis of Soils
 8. ASTM D 695 – Test Method for Compressive Properties of Rigid Plastics
 9. ASTM D698 – Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort
 10. ASTM D 1621 – Test Method for Compressive Properties of Rigid Cellular Plastics
 11. ASTM D 3034 – Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
 12. ASTM D4318 – Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
 13. ASTM F 758 – Standard Specification for Smooth-Wall Poly(Vinyl Chloride) (PVC) Plastic Underdrain Systems for Highway, Airport, and Similar Drainage
- C. American Association of State Highway and Transportation Officials (AASHTO)
1. AASHTO M 252 – Corrugated Polyethylene Drainage Tubing
- D. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Aggregate

1. Aggregates shall consist of clean, sound, durable particles of crushed stone or crushed gravel and shall be free from coatings of clay, silt, vegetable matter, and other objectionable materials and shall contain no clay balls.
2. Fine aggregate (passing the No. 4 (4.75 mm) sieve) shall consist of fines from the operation of crushing the coarse aggregate. If necessary, additional fine aggregate may be added to produce the correct gradation. All fine aggregate shall be produced by crushing stone or gravel that meets the requirements for wear and soundness specified for the coarse aggregate.

3. The crushed aggregate portion which is retained on the No. 4 (4.75 mm) sieve shall contain not more than 15%, by weight, of flat and elongated pieces as defined in ASTM D 4791 (ratio = 5:1) and shall have at least 90% by weight of particles with at least two fractured faces and 100% with at least one fractured face. The area of each face shall be equal to at least 75% of the smallest midsectional area of the piece. When two fractured faces are contiguous, the angle between the planes of fractures shall be at least 30 degrees to count as two fractured faces.
4. The percentage of wear shall not be greater than 35% when tested in accordance with ASTM C 131.
5. The magnesium sulfate soundness loss shall not exceed 15%, after 5 cycles, when tested in accordance with ASTM C 88.
6. The fraction passing the No. 40 (0.42 mm) sieve shall have a liquid limit no greater than 25 and a plasticity index of not more than 8 when tested in accordance with ASTM D 4318. The fine aggregate shall have a minimum sand equivalent value of 35 when tested in accordance with ASTM D 2419.
7. Gradation Requirements: The gradation of the final mixture shall fall within the design range indicated in Table 2, when tested in accordance with ASTM C 117 and C 136. Pipe Underdrain Aggregate shall conform to the following gradations:

Sieve Size	Percent Passing by Weight
1½ in (37.5 mm)	-
1 in (25.4 mm)	-
¾ in (19 mm)	100
3/8 in (9.5 mm)	85-100
No. 4 (4.75 mm)	-
No. 8 (2.36 mm)	40-60
No. 16 (1.18 mm)	-
No.30 (0.6 mm)	5-30
No. 50 (0.3 mm)	-
No. 100 (150 um)	0-2

A. Underdrain Pipe

1. Polyvinyl Chloride pipe shall meet the requirements of ASTM F758/D3034.
2. Corrugated Polyethylene Tubing shall be the heavy duty type and shall meet the requirements of AASHTO M 252 for 4" through 10" pipe

and AASHTO M294 or ASTM F2306 for 12" through 60 inch. In addition, the tubing shall have a minimum pipe stiffness of 30 psi (210 kPa) at 10% deflection.

3. Virgin material for pipe and fitting production shall be high density polyethylene conforming with the minimum requirements of cell classification 424420C for 4- through 10-inch diameters, or 435400C for 12- through 60-inch diameters, as defined and described in the latest version of ASTM D3350, except that carbon black content shall not exceed 4%. The 12- through 60-inch virgin pipe material shall comply with the notched constant ligament-stress (NCLS) test as specified in Sections 9.5 and 5.1 of AASHTO M294 and ASTM F2306, respectively.
4. All underdrain pipes shall have a nominal minimum inside diameter of six inches (150mm) unless shown otherwise on Plans.
5. Perforations shall be approximately circular and cleanly cut; shall have nominal diameters not less than 3/16-inch (5mm) nor more than 3/8-inch (10 mm); and shall be arranged in at least two rows parallel to the axis of the pipe.
6. Fittings shall be of the same composition and have the same physical properties as the pipe and shall not restrict flow.

B. Geotextile Filter Fabric

1. Geotextile for use with pipe and edge underdrains shall be a nonwoven geotextile filter fabric. The synthetic fiber shall consist of polypropylene, nylon, or polyester filaments. The percent open area shall be not less than 4 percent nor more than 10 percent. The cloth shall provide an Equivalent Opening Size (EOS) no finer than the U.S. Standard Sieve No. 100. In addition, filter fabric shall meet the following physical requirements:
 - a. Tensile Strength: Minimum grab tensile strength, both warpwise and fillingwise, shall be 200 pounds when tested in accordance with ASTM D 5034, using a 4-inch by 6-inch specimen and a jaw speed of 12 inches per minute.
 - b. Elongation: Grab elongation shall be not less than 15 percent nor more than 60 percent, both warpwise and fillingwise, when tested in accordance with ASTM D 5034.
 - c. Tear Strength: Minimum trapezoid tear strength shall be 100 pounds, both warpwise and fillingwise. Method of test for woven fabrics shall be in accordance with ASTM D 4533.
 - d. Bursting Strength: Minimum bursting strength shall be 400 psi when tested in accordance with ASTM D 3887.

- e. Seam Strength: Woven fabric shall have a minimum seam-breaking strength of 180 pounds when tested in accordance with ASTM D 1683, using a jaw speed of 12 inches per minute.
- f. Width: Filter fabric shall be furnished in widths of not less than 6 feet.

PART 3 - EXECUTION

3.01 CONSTRUCTION

A. General

1. The exact location and layout of underdrains and/or edge drains as shown on the Plans shall be subject to revision by the Engineer as determined during construction.

B. Excavation

1. Trenches for all lateral and longitudinal underdrains shall be excavated to the dimensions, depths and elevations or as ordered by the Engineer. In case of a conflict, where the actual elevation of the strata or stratum to be intercepted is found to vary from Plan elevation, the stratigraphy shall govern in the installation of underdrains.
2. Trench bottoms for perforated pipe underdrain and edge drain shall be in firm material (no mucky or soupy condition existing) and constructed to permit the placing of three inches (75 mm) of aggregate underneath the pipe. If unstable material is encountered in the bottom of the trench, the trench shall be over excavated to firm material.
3. Minimum width of trench shall be as shown on the Plans.

C. Laying Pipe

1. All underdrain pipe shall be laid carefully to line and grade.
2. All pipe shall be laid on a minimum grade of one percent unless otherwise shown on the plans.
3. All dead ends of pipe underdrains shall be completely closed with a cap of the same material as the pipe.
4. All junctions and turns shall be made with wyes, tees, and bends as supplied by the manufacturer of the pipe.
5. Perforation shall be laid down unless otherwise indicated on the Plans.

D. Backfilling

1. Backfilling the trenches of lateral and longitudinal underdrains shall not be started until approved by the Engineer or the Inspector.
2. The trenches shall be backfilled to the elevations shown on the Plans.
3. The backfill material shall be placed in such a manner as to prevent formation of large cavities in the backfill and walls of the trench.
4. The backfill material shall be placed in such a manner as to prevent formation of large cavities in the backfill and walls of the trench.

END OF SECTION 33 46 16.19

SECTION 33 49 13**STORM STRUCTURES****PART 1 - GENERAL****1.01 SCOPE OF WORK**

- A. This section governs the performance of all work necessary for construction of cast-in-place and precast concrete structures for inlets, manholes, junction boxes, and incidental structures. Masonry structures shall not be allowed under these Specifications.

1.02 DESCRIPTION

- A. Storm sewer construction shall consist of furnishing all labor, materials and equipment for the complete installation of storm sewer structures and incidentals in accordance with Contract Drawings and these specifications and as specified in American Public Works Association Standard Specifications and Design Criteria Section 2600 as revised, adopted, and provided by the Director of Kansas City, Missouri Public Works current at the time of bidding and American Public Works Association Standard Specifications.

1.03 REVISIONS OF STANDARDS

- A. In addition to complying with all pertinent codes and regulations, comply with the referenced or applicable portions of the American Public Works Association Standard Specifications and Design Criteria as revised, adopted, and provided by the director of Kansas City, Missouri Public Works current at the time of bidding.
- B. When reference is made to a Standard Specification, i.e., ASTM, ANSI, AWWA, the Specification referred to shall be understood to mean the latest revision of said specifications as amended at the time of the Notice to Bidders, except as noted on the Drawings or in the Specific Project Requirements section of these specifications.

PART 2 - PRODUCTS**2.01 MATERIALS**

- A. Concrete Mixes: Concrete shall be MCIB Mix Number A564-3/4-4 or A543-1-4 at the Contractor's option; except concrete used for soil stabilization, pipe cradles, filling, leveling courses, and other similar purposes may be either MCIB Mix Number A440-3/4-4 or A473-1/2-4. Using a mechanical mixer, concrete may be prepared on-site to construct inverts only for pre-cast structures having developed bases. Concrete

may be either MCIB Mix Number 495-3/4-4 or 527-1/2-4 at the Contractor's option. A maximum of 7 gallons of water per sack of cement is in the design for both of these mixes.

B. Concrete Materials:

1. Concrete materials shall conform to MCIB Section 1 Concrete Materials, except that total shale, coal, and lignite content shall not exceed 0.5 percent by weight, and clay content shall be zero
2. Concrete shall conform to all requirements of MCIB and the compressive strength of each mixture shall be as designated therein.

C. Reinforcing Steel: Reinforcing bars shall conform to ASTM C 615, Grade 60. Welded steel wire fabric shall conform to ASTM A 185.

D. Precast Concrete Structures:

1. Manholes: Precast manholes shall conform to ASTM C 478. Manholes are classified by their inside diameter dimension, and shall conform to the dimensions indicated on the Contract Drawings.
2. End Sections: End sections for concrete pipe shall be flared end sections of the pipe manufacturer's standard design, and shall meet all applicable requirements of ASTM C 76 for Class II or higher classes of pipe.
3. Rectangular Structures: Rectangular structures shall conform to the dimensions indicated on the Contract Drawings and be designed for the following loads:
 - a. H-20 live load for all structures in/or under pavement, shoulders, driveways, and other traffic areas.
 - b. 2,000-lb wheel live load for curb opening inlets and junction boxes in non-traffic areas.
 - c. 50-pcf equivalent fluid pressure for soil pressure on vertical walls.
 - d. 120 pcf for unit weight of soil cover on top slabs.

E. Joints: Joints between concrete structures shall be filled with plastic joint compound or preformed plastic compound as stated herein.

1. Barrel Sections: Minimum cross sectional area of preformed compound between concrete barrel sections shall be 1 inch square or 1.25 inches diameter. Minimum cross-sectional area of the preformed compound between the concrete adjustment ring and the cone barrel section shall be two beads of either 1 inch square or 1.25 inches in diameter.

2. Manhole Adjustment Rings: Rings shall be constructed of concrete, HDPE, or recycled rubber.
 - a. If HDPE adjustment rings are used, they shall be injection molded-recycled HDPE - as manufactured by LADTECH, Inc. or approved equal. They shall be bolted to the manhole cone section and otherwise installed as per manufacture's recommendations.
 - b. If recycled rubber adjustment rings are used, they shall consist of no less than 80%, by weight, recycled rubber and no less than 10% by volume shredded fiber as manufactured by GNR Technologies or approved equal. They shall be installed as per manufacture's recommendations.
 - c. The top and bottom of all adjustment rings shall be sealed using a mastic filler meeting the requirements of Section 2510.3.E.6 of APWA or an epoxy paste. The epoxy paste shall be a two component, moisture insensitive, containing no solvents, and capable of bonding with all materials it is to be used on, like Epoxytec Micor C.P.P or approved equal. Minimum cross-sectional area of preformed compound between concrete adjustment rings shall be two beads of either 1 inch square or 1.25 inches in diameter.
 3. Manhole Ring and Covers: Minimum cross-sectional area of preformed compound between the adjustment ring and the manhole casting shall be two beads of either 1 inch square or 1.25 inches in diameter.
 4. Internal Manhole Chimney Frame Seal: Internal frame seal shall consist of a flexible rubber sleeve, interlocking adjustment extension(s), and stainless steel compression bands. The flexible rubber sleeve and extension shall be extruded or molded from a high grade rubber compound conforming to the applicable requirements of ASTM C 923 with a minimum tensile strength of 1500 psi and minimum elongation at break of 350%. At a minimum, the compression bands shall be 16-gauge stainless steel conforming to ASTM A 240, Type 304, with a minimum width of one inch. Screws, nuts, and bolts shall be stainless steel conforming to ASTM F 593 and 594, Type 304. The compression bands shall have the capacity to tighten with enough pressure to make a watertight seal around the rubber chimney sleeve.
- F. Air Entrainment: All concrete, unless otherwise stated in Section 2.1 A, APWA Section 2510.2.F.C., or MCIB Section 3 shall be air entrained. Minimum strength requirements shall be as specified in Section 2.1 B.2 above.
- G. Manhole Castings:
1. Rings and Covers: Castings shall be gray iron conforming to ASTM A 48, Class 35B. Castings of rings and covers shall be of the shape,

dimension, minimum weight, and type as indicated on Standard Drawing "MH-RC4C," and be free from manufacturing defects. All curb inlet castings shall have cam locks. Storm Sewer manhole ring and covers shall be "MH-RC Type 3". If requested by special order, castings shall be cleaned and painted with one coat of tar prior to delivery. Bearing surfaces between all rings and covers for installation in all areas shall be machined to provide even seating and interchangeability of like pieces.

- a. All manhole rings and covers placed in paved areas or as directed by the Water Services Department Engineer shall be adjustable to meet any slope and grade of the roadway, from 0 to 17%, and shall be able to be raised or lowered in ¼ inch increments, up to 2¾ inches. Ring height must be adjustable after installation without disturbing the surrounding pavement. The ring and lid shall be rated for H20 traffic. Cam lock covers shall not be placed in roadway pavement unless shown on the plans or directed by the engineer. All covers shall have provisions for opening, such as concealed pick holes.
2. Steps: All steps shall comply with APWA Section 2510.3.H.2. and the most recent Supplement to APWA Section 2500. Cast iron steps shall not be used.
- H. Steel End Sections: Steel end sections shall be fabricated from galvanized or aluminized base metal as specified in APWA Section 2602, and shall be flared end sections of the metal pipe manufacturer's standard design. End sections shall be furnished with a steel toe plate. Bituminous coating is not required.
 - I. Toe Walls: Flared end sections for concrete and steel pipe shall be set on a concrete toe wall centered on the end of the section. Toe walls shall be 8 inches thick by 24 inches deep by the width of the bottom of the cut trench.
 - J. Resin Adhesive: Injectable adhesive shall be used for installation of all reinforcing dowels into adjacent precast concrete. Adhesive shall be HILTI HIT HY or HIT-ICE or approved equal. Drill holes and install adhesive/dowels per manufacturer. Work is subsidiary to C.I.P. headwall concrete.

PART 3 - EXECUTION

3.01 Concrete Structures

- A. Concrete construction shall conform to the MCIB Standard Specifications.
 1. Precast Structures: The Contractor may, at his option, construct precast concrete inlets, and junction boxes, in lieu of the cast-in-place structures indicated on the Contract Drawings; except that all concrete base slabs for pre-cast inlets, manholes, and junction boxes may be cast-in-place. Solid concrete brick or block shall be used to

block inlets and similar structures to grade during placement of base slab concrete.

2. Finishing: Exposed edges of all slabs, walls, and other concrete structures shall be beveled $\frac{3}{4}$ " or edged with a 1 $\frac{1}{4}$ " radial tool.
 - a. Formed Surfaces: Immediately following removal of forms, fins and irregular projections shall be removed. Form tie connections, holes, honeycomb spots, and other defects shall be chipped to ensure the voided area is exposed, and shall be chipped back to solid material. These areas shall be thoroughly cleaned, saturated with water, and pointed with a grout approved by the Engineer. The repaired surfaces shall be cured in accordance with MCIB Specifications.
 - b. Exposed Slabs: Finish for exposed slabs shall be wood float texture in accordance with MCIB Specification.
 3. Form Removal: Forms shall remain in place until the concrete has attained sufficient strength to support loads imposed by backfilling, construction, and traffic. Within 24 hours of form removal, small holes and pockmarks of exposed walls shall be filled with Portland cement grout and rubbed smooth. Concrete voids and honeycombs shall be chipped open with a light hammer to expose weak areas for inspection. At the direction of the Engineer, expansive repair grout shall be used for partial reconstruction of otherwise sound structures.
 - a. Walls: Forms shall remain in place until the concrete reaches a minimum strength of 2000 p.s.i.
 - b. Slabs: Forms shall remain in place until the concrete reaches a minimum strength of 3000 p.s.i.
 4. Manhole Riser Adjustments: Manhole rings and covers shall be adjusted to match the slope and height, or grade, of pavements. In no case shall the surface pitch of the manhole ring and cover mismatch the pavement slope by more than $\frac{1}{4}$ inch. The difference in height between the top of manhole cover and the top of precast cone shall not exceed 24 inches.
 - a. In lieu of replacing concrete adjustment rings that are properly seated and structurally sound but have a small fracture, an external rubber chimney may be fitted to secure a watertight seal between the casting (manhole ring and cover) and the concrete cone barrel section.
- B. Invert Channels: Form concrete invert channels in manholes, inlets, and junction boxes to make changes in direction of flow with smooth curves of as large a radius as permitted by the inside dimension of the structure. Grade changes and transitions shall be smooth and uniform, and all parts of the invert channel and adjacent floor shall slope to drain. Channel bottom shall be finished smooth without roughness or irregularity. Invert channels for

precast concrete structures may be cast integrally with the structure base slabs at the Contractor's option.

- C. Excavation: All excavation shall be done in conformance with Section 31 22 00, 3.03 A. 1. entitled "Grading."
1. Excavation for structures shall be carried a sufficient distance, but not less than 18 inches outside the limits of the structure, to permit efficient erection and removal of forms and laying of masonry units, and shall be sloped, stepped, or braced as required for stability. Unsuitable soils encountered at the bearing elevation of the structure shall be removed and replaced with either fill concrete or compacted granular material at the Contractor's option. Over excavation shall be corrected in like manner. The Contractor shall maintain the excavation free of standing water until backfilling is complete.
- D. Backfill of Structures: All excavations of structures, such as cast-in-place and precast concrete structures for inlets, manholes, junction boxes shall be backfilled with suitable material placed and compacted in conformance with these specifications and as shown on the drawings.
1. Street Right-of-Way Areas: The trenched backfill areas around all storm sewer inlets, junction boxes, and manholes shall be backfilled with removable flowable-fill (CLSM) to a level flush with the bottom of pavement subgrade for paved areas or twelve-inches below finish grade for non-paved areas. In non-paved areas, the top twelve inches shall be consolidated soil; the top six inches shall be topsoil.
 - a. The external opening surfaces of weep holes shall be covered with hardware cloth and surrounded with a minimum of three cubic feet of consolidated granular bedding material.
 2. Areas other than Street Right-of-Way: The trenched backfill areas around all City-maintained storm sewer inlets, junction boxes, and manholes located within the pavements of private streets, driveways, and parking lots shall be backfilled as specified for the paved areas in Section 3.1 D.1 (above). City-maintained storm sewer structures that are located in non-paved areas shall be backfilled with removable CLSM, untreated compacted aggregate, consolidated granular bedding material, or compacted soil to a level twelve inches below finish grade. In non-paved areas, the top twelve inches shall be consolidated soil; the top six inches shall be topsoil.
 3. Backfilling: Backfilling shall conform to the requirements of this Section, the drawings, and as follows:
 - a. All trenches and excavations shall be backfilled with suitable material placed and compacted in conformance with this Section and Section 31 22 00.

- b. Controlled low strength material (CLSM), or flowable fill as it is commonly known, shall be used for all trenches under street or alley pavements and for structures adjacent to pavements up to the level of the pavement subgrade. The pavement subgrade is a six to twelve-inch thick layer that consists of uniformly compacted material at 95% of standard max. density.
- c. No backfill shall be placed over or around any structure until the concrete or mortar therein has attained a minimum strength of 2000 p.s.i. and can sufficiently support the loads imposed by the backfill without damage.
- d. The Contractor shall use utmost care to avoid any wedging action between the side of the excavation and the structure that would cause any movement or floating of the structure. Any damage caused by premature backfill or by the use of equipment on or near a structure will be the responsibility of the Contractor.
- e. Backfill shall be placed and compacted on all sides of the structure simultaneously, and operations shall be so conducted that the backfill is always at approximately the same elevation on all sides of the structure.
- f. No excavated rock larger than 4 inches maximum dimension shall be placed within 1 foot of the exterior surface of any structure.

END OF SECTION 33 49 13

SECTION 34 11 00**RAIL****PART I - GENERAL****1.1 SUMMARY****A. Scope**

1. This specification covers carbon steel rails that are intended for use as tee rails and grooved rails for streetcars.

1.2 REFERENCES**A. American Railway Engineering and Maintenance-of-Way Association (AREMA):**

1. AREMA – “Manual for Railway Engineering” (AREMA Manual)

PART II - PRODUCTS**2.1 TEE RAIL**

- A. 115 RE section either standard or premium rail in accordance with the requirements of AREMA “Specifications for Steel Rails” and as specified.

2.2 GROOVED RAIL MANUFACTURE

- A. The steel shall be melted using electric-furnace process.
- B. The steel in liquid form shall be vacuum degassed.
- C. The steel shall be produced using a continuous casting process. The minimum reduction ratio from cast bloom to final product will be 8:1.
- D. The Product shall be hot rolled.
- E. All aspects of the Manufacturer’s quality system shall be in effect.

2.3 GROOVED RAIL CHEMICAL COMPOSITION

- A. The chemical composition will depend on grade, either standard strength or premium strength. Final chemical testing will be from the tundish during casting and will represent the front and back of the heat. The average of the tests will be reported. Finished material representing the heat may be product tested. The product analysis shall be considered as meeting the specification if they are within the limits specified on the right side of the tables below.

1. Standard Strength

<u>Element</u>	<u>Chemical Analysis (wt %)</u>	<u>Product Analysis Tolerance (wt %)</u>	
		<u>Under Min.</u>	<u>Over Max.</u>
Carbon	0.50 - 0.65	0.02	0.02
Manganese	1.00 - 1.25	0.05	0.05
Phosphorus Max.	0.025		0.008
Sulfur Max.	0.025		0.008
Silicon	0.15 – 0.58	0.02	0.02
Chromium Max.	0.15		0.03
Molybdenum Max.	0.050		
Aluminum Max.	0.010		
Copper Max.	0.40		
Hydrogen Max.	3.0 ppm		

2. Premium Strength

<u>Element</u>	<u>Chemical Analysis (wt %)</u>	<u>Product Analysis Tolerance (wt %)</u>	
		<u>Under Min.</u>	<u>Over Max.</u>
Carbon	0.62 - 0.80	0.02	0.02
Manganese	0.70 - 1.20	0.05	0.05
Phosphorus Max.	0.025		0.008
Sulfur Max.	0.025		0.008
Silicon	0.15 – 0.58	0.02	0.02
Chromium Max.	0.15		0.03
Molybdenum Max.	0.050		
Aluminum Max.	0.010		
Copper Max.	0.40		
Hydrogen Max.	2.5 ppm		

B. Hydrogen

1. Hydrogen shall be subject to the limits listed above. If the hydrogen exceeds those limits, the blooms from the heat shall be slow cooled and the rails will be tested.

PART III – EXECUTION**3.1 MECHANICAL PROPERTIES AND ELECTRICAL RESISTANCE**

- A. Brinell Hardness will be measured on the running surface of the rail after the decarburized layer has been removed. The frequency of testing shall be once per heat and will be constructed in accordance with ASTM E10. For standard strength, the minimum hardness will be 220 BHN. For premium strength, the minimum hardness will be 260 BHN.
- B. Tensile tests will be taken from the running surface corner of the rail. The frequency shall be once per heat and will be conducted in accordance with ASTM A370. Results will be determined by grade. For standard strength, the minimum tensile strength will be 113 ksi with a 12% elongation. For premium strength, the minimum tensile strength will be 128 ksi with a 10% elongation.
- C. If any tests fail to meet the requirements of 2.3.A or 2.3.B, then two further tests shall be performed on samples from two other rails from the same heat. If those two tests are successful, the rails from the heat are acceptable.

- D. Direct current resistance shall be measured on one rail per heat and shall not be more than 10.5 micro-ohms ($\times 10^{-6}$ ohms) per foot. Alternatively, the electrical resistance can be determined by calculating the electrical resistivity ratio in comparison to pure copper. The calculated resistivity ratio to Cu will be 15.0 maximum.

3.2 DIMENSIONAL TOLERANCES

- A. The drawings of the rail along with the nominal dimensions is listed in Appendix A. Dimensional tolerances to nominal are as follows:

Height of Rail (running or groove side)	-0.020"/ +0.040"
Width of Groove	-0.040"/ +0.040"
Depth of Groove	-0.040"/ +0.040"
Width of Running Rail Head	-0.040"/ +0.040"
Overall Top Width	-0.080"/ +0.060"
Base Width	-0.125"/ +0.125"
Base Concavity	-0.000"/ +0.040"
Twist	0.063" max

3.3 IDENTIFICATION

- A. The rail will be cold stamped on the grooved head (not running surface) once on each end of the rail. The cold stamp will include manufacturer code, grade (standard or premium) and heat number (AM S x#### or AM P x####). The letter in the heat number specifies year produced.

3.4 SURFACE IMPERFECTIONS

- A. All rails shall undergo visual surface inspection to cull injurious imperfections.
- B. Surface imperfections may be conditioned as long as the rail microstructure is not affected by the operation. This may be accomplished by using appropriate methods (lamellar flap tool, grinding belt, etc.)
- C. Protrusions
1. Protrusions on the running surface or underside of the base shall be dressed smooth.
 2. Protrusions on any other surface are allowed up to 0.060". Protrusions higher than 0.060" may be conditioned down to 0.060".
- D. Depressions
1. Depressions in the base and rail body:
 - a. Hot scratches, scratches, and grooves that are principally longitudinal to the rail axis shall not exceed a depth of 0.040". Imperfections principally transverse to the rail axis shall not exceed 0.030". Transverse imperfections greater than 0.020" but not less than 0.040" may be conditioned down to 0.030".
 - b. Seams are allowed up to a depth of 0.040" and a surface area of 0.160" (transverse) by 1.180" (longitudinal).

- c. Overlaps are allowed of up to 0.020" deep and can extend the full length of the rail.
- d. Cold marks are allowed up to 0.020".
- 2. Depressions in the running surface:
 - a. Imperfections in the running surface shall not exceed 0.020" in depth.
 - b. Principally longitudinal defects shall be a maximum of 0.160" wide, and principally transverse defects shall not have an area exceeding 0.400" x 0.080".

3.5 STRAIGHTNESS

- A. The rail will be straightened in a roller straightening process.
- B. End Straightness:
 - 1. The straightness of the ends of the rails shall be checked with a 3' straightedge. Within this length, deviations from straightness in the vertical or horizontal directions shall not exceed 0.030". The deviation in the vertical direction is only allowed if the end has a continual upsweep.
- C. Line Straightness:
 - 1. Line straightness from end to end shall be checked with the naked eye. If there is a sharp kink, it shall be further examined and corrected. For general sweep, if an imaginary line was drawn from one end to the other of a 40' rail, the maximum tolerable gap will be 1".

3.6 COLD SAWING

- A. The cut shall be square in both the vertical and horizontal directions with a maximum deviation of 0.30".
- B. Any excessive saw burr will be removed. No beveling of the end will be allowed.

3.7 CERTIFICATION

- A. A certified mill test report will be issued with the results of the chemical and mechanical testing to confirm the product meets this specification.

PART 4 - MEASUREMENT

- 4.1 **Measurement** – No Separate measurement will be made for Work described in this Section.

PART 5 - PAYMENT

- 5.1 **Payment** – Payment for items in this Section will be incidental to the Contract unit cost of the Embedded Track bid items.

END OF SECTION

SECTION 34 11 16**TRACKWORK - FIELD RAIL WELDING****PART I - GENERAL****1.1 SUMMARY****A. Description**

1. The work specified in this section shall include providing materials, equipment, laboratory and quality control testing of rail welds, and labor necessary to weld together the abutting ends of rail, and qualification of welding and welders. Rail welds shall be one of the two types indicated below:
 - a. Pressure (Electric Flash-Butt) Welds: Tee rail and TRAM rail for ballasted mainline track, embedded/paved tracks, direct fixation (DF) tracks, and yard body tracks outside the limits of special trackwork shall be welded into continuous strings using the electric flash-butt pressure welding process.
 - b. Thermite Welds: Thermite welds shall be used to weld the strings together. String length shall be as long as possible but not be less than 150 feet without Engineers approval. Thermite welds shall be used in rail for use in embedded (paved) and ballasted track and within the limits of grade crossings. Shop pre-curved rail shall be thermite welded in place in the track.
2. Pressure welding shall be performed using mobile electric flash-butt welding machine designed for rail welding.
3. The Contractor shall make his own assessment as to the number of rails to be welded under this Contract, and the number of welds to be made by any one welding process, based on the information contained in these Specifications and the Contract Drawings.

1.2 REFERENCES

- A. Association of American Railroads (AAR):
 1. AAR - Specification for Quality Assurance, M-1003.
- B. American Railway Engineering and Maintenance-of-Way-Association (AREMA):
 1. AREMA - "Specifications for Fabrication of Continuous Welded Rail"
 2. AREMA - "Specifications for Steel Rails"
 3. AREMA - "Specifications for Thermite Welding Rail Joints"
- C. American Welding Society (AWS):
 1. AWS D1.1/D1.1M - Structural Welding Code Steel
- D. ASTM International (Formerly known as American Society for Testing and Materials) (ASTM):

1. ASTM E10-12 - Standard Test Method for Brinell Hardness of Metallic Materials
2. ASTM E94-04(2010) - Standard Guide for Radiographic Examination
3. ASTM E164-13 - Standard Practice for Ultrasonic Contact Examination of Weldments
4. ASTM E709-08 - Standard Guide for Magnetic Particle Testing

1.3 SUBMITTALS

- A. Certification: Submit manufacturer's certification for foreman and crew.
- B. Pressure (Electric Flash-Butt) Welds: Submit the following:
 1. A written description of the welding procedure, including facilities, personnel and list of similar completed projects.
 2. A list of equipment and calibration methods, method of rail end alignment, method of rail straightening.
 3. Welding Machines Performance: Submit pressure welding machine performance standards as provided by the manufacturer. During welding production, a recorder shall be attached to each welding machine to record platen movement and current impulses on the form "Record of Field Welds". A record of machine performance for each weld shall be submitted to the Contracting Officer. If the record indicates performance which is not in conformance with the approved standards, the weld will be considered defective and shall be rejected.
 4. Shop Drawings: Submit Shop Drawings for the pressure welding machine and Shop Drawings of the proposed method and equipment for handling and laying CWR. This submittal shall include reference data relating to where the proposed equipment and laying method were previously successfully used.
 5. Details of the equipment and procedure proposed for straightening welds if required. The submittal shall include reference data relating to where the proposed straightening equipment and method were previously successfully used.
 6. The manufacturer's recommended procedure for welding high strength rail if different from requirements for standard rail.
 7. Pressure Weld Samples: Prior to beginning of production welding, two test welds shall be made using the welding machine and the procedures proposed in the Manufacturer's instructions for each type of rail used. The two welds shall be standard rail to standard rail. The welds shall be tested by the testing service. Certified test reports shall be submitted to the City. The test welds may be part of a continuously welded rail string at the contractor's discretion.
 8. Proposed location for flash-butt welding plant including methods of transporting materials and equipment to the site, types and locations of environmental controls and duration of welding operations.
- C. Thermite Welds: Submit the following:

1. Prepare a detailed description covering the step-by-step procedures to be employed in making the welds. Include a complete description of each of the following applicable items as well as any other characteristics essential to the welding procedures.
 - a. The manufacturer's trade name for the welding process.
 - b. The method used for cutting and cleaning of the rail ends. Flame cutting of rail ends will not be allowed.
 - c. The minimum and maximum spacing between rail ends.
 - d. The method used for maintaining the rails in alignment during welding.
 - e. The method used for preheating, including time and temperature.
 - f. The tapping procedure, including the minimum time required to cool the weld under the mold insulation.
 - g. The method used, including a description of special tools and equipment, for removing the upset metal and finishing the weld to the final contour.
 - h. The manufacturers recommended procedure for welding high strength rail if different from requirements for standard rail.
 - i. Method for controlling smoke and fumes from field welding within indicated requirements.
 - j. The manufacturer's recommended procedure for welding block or girder rail if different from requirements for standard rail.
 - k. Quality control procedures.
 2. Documentation: Prepare, maintain, and make available to the Contracting Officer a complete welding record indicating kit manufacturer, welding foreman, rail temperature, weather conditions, and station location.
- D. Calibrations: Submit description of calibration equipment and calibration methods.
- E. Testing Programs for Field Quality Control: Submit testing programs prepared by the radiographic, ultrasonic, and magnetic particle weld testing services for approval by the Contracting Officer. Each program shall include a description of the proposed procedures, materials, equipment, safety requirements, and report.

1.4 QUALITY ASSURANCE

- A. Welding Supervision:
1. Perform welding under the direct supervision of an experienced rail welding supervisor or foreman.
 2. Qualify each field welding foreman and crew through a representative of the field rail welding process manufacturer.

PART II - PRODUCTS**2.1 RAIL WELDING**

- A. Perform field rail welds utilizing one of the following brands of rail welding or an approved equal. All field welds shall only be preheated type.
 - 1. Field Flash Butt Welding: Process by Holland or approved equal.
 - 2. Calorite: Standard preheat, as manufactured by Calorite Inc., Addison, Illinois.
 - 3. Boutet: As distributed by DuWel Steel Products Company, Chicago, Illinois.
 - 4. Orgo-Thermit: As distributed by Orgo-Thermit Company, Lakehurst, New Jersey.
 - 5. Railwel Canada 175 boul J.F. Kennedy, St. Jerome, Quebec, Canada J7Y4B5
- B. Unless otherwise shown or specified, conform to the rail welding kit manufacturer's recommended standards when welding high strength rail.

2.2 RAIL

- A. Rail for welding shall be as specified in Section 34 11 29, "General Track Construction".

PART III - EXECUTION**3.1 RAIL END PREPARATION**

- A. Clean the rails to be free of grease, oil, dirt, loose scale, and moisture to a minimum of six inches back from the rail ends, including the rail end surfaces, by use of a wire brush.
- B. Align the faces of the rail ends.
- C. Clean for 2 inches on each side of the weld, to remove scale and rust, using a power actuated grinder with abrasive wheel.
- D. Rail ends shall show no steel defects, dents, or porosity before welding.
- E. If rail is required to be cut to length for any reason, cut it square and clean by means of rail saws or abrasive cutting wheels in accordance with AREMA, "Specifications for Steel Rails".

3.2 RAIL

- A. Straighten rail not meeting the requirements of AREMA, "Specifications for Fabrication of Continuous Welded Rail", shall be within the specified tolerance.
- B. If any rail cannot be straightened, cut it back a sufficient distance to achieve the required alignment.
- C. Perform all straightening or cutting prior to welding.

3.3 RAIL GAP

- A. Align and properly gap the ends of the rails to be welded to produce a weld which conforms to the alignment tolerances specified.

- B. Hold the rail gap and alignment during field welding without change during the complete welding cycle.
 - 1. Align rail on the head of the rail:
 - a. Vertical alignment: To provide for a flat running surface. Any difference of height of the rails shall be in the base.
 - b. Horizontal alignment: In such a manner that any difference in the width of heads of rails occurs on the field side.
 - 2. Horizontal offsets: Not to exceed 0.040 inch in the head and 0.125 inch in the base.
 - 3. Surface misalignment tolerance:
 - a. Combined vertical offset and crown camber: Not to exceed 0.040 inch per foot.
 - b. Combined vertical offset and dip camber: Not to exceed 0.010 inch per foot.
 - 4. Gauge misalignment tolerance: Combined horizontal offset and horizontal kink camber not to exceed 0.040 inch per foot.

3.4 BOLT HOLES

- A. One handling hole may be made in each end of a CWR string. Cut off rail ends containing such holes prior to welding.

3.5 FIELD WELD POSTHEATING

- A. Leave the molds in place after tapping for the time required to permit complete solidification of the molten metal and proper slow cooling to prevent cracking and provide a complete weld with proper hardness and ductility.

3.6 PRESSURE (ELECTRIC FLASH-BUTT) WELDING

- A. Pressure welding shall be in accordance with the AREMA Specification for, "Fabrication of Continuous Welded Rail" except as modified hereinafter.
- B. Mismatched or jagged rail ends shall be either sawed or cut with an abrasive rail cutter. Mating rail ends by flashing shall not be accepted.
- C. Rails shall have the scale removed down to bright metal in areas where the welding current-carrying electrodes contact the rail. Grind down raised rail brands in electrode areas. The weld and adjacent rail for a distance clearing the electrodes shall be rejected if in the areas of electrode contact there is not more than 95 percent of the mill scale removed. Electrode contact areas shall be examined for evidence of electrode burn. Where metal is displaced or where the oxidized areas exhibit checks or small cracks the weld shall be rejected and the rail cut back clear of the electrode burn.
- D. Welds shall be forged to point of refusal to further plastic deformation and shall have a minimum upset of 1/2 inch, with 5/8 inch as standard.

- E. If flashing on electric pressure (flash butt) welds is interrupted, because of malfunction or external reason, with less than 1/2 inch of flashing distance remaining before upsetting, rails shall be re-clamped in the machine and flashing initiated again.
- F. Whenever possible, grinding shall be accomplished immediately following welding at an elevated temperature. When grinding must be done at ambient temperature, avoid grinding burns and metallurgical damage.
- G. Alignment of rail in the welding machine shall be at the head of the rail.
 - 1. Vertical alignment shall provide for a flat running surface. Any difference of height of the rail shall be in the base.
 - 2. Horizontal alignment shall be accomplished in such a manner that any difference in the width of heads of rails shall be divided equally on both sides of the head. Where the difference, when divided, exceeds 0.040 inches, 0.020 inches of the difference shall be placed on the gauge side and the remaining differences in the width of heads shall be on the field side.
 - 3. In any case horizontal offsets shall not exceed 0.040 inch at the head and/or 0.125 inch at the base.
- H. Surface and Gauge Misalignment Tolerances: Shall meet the alignment tolerances given in the AREMA Manual, Chapter 4, Part 2, "Tolerances for Inspection of Welded Rail New and Mainline Relay Rail".
- I. If, at any time, 7 or more of a series of 12 consecutive welds made on one machine exceed 75 percent of the stated surface misalignment tolerances that machine shall be shut down and adjusted before work continues.
- J. Re-welds shall be cut out beyond the heat affected zone of the previous weld.

3.7 WELD FINISHING AND TOLERANCES

- A. Bring rails and joints in the finished track to a true surface and alignment by means of an approved grinding machine.
- B. Finish the completed weld for 112 TRAM rail by grinding to conform with the following requirements (see attached 112 TRAM rail drawings for clarification):
 - 1. Finishing deviation shall not be more than plus 0.010 inch to minus 0.0 inch of the parent section of the rail head surface. Grinding of the parent rail metal is acceptable as long as the minimum rail cross section is maintained. Top of the head of the running rail will be checked with a 3 foot straight edge to verify that there are no low spots or valleys in the head of the finished weld/rail around the weld. If low spot/valley cannot be blended, weld will be rejected and cut out along with the heat affected zone of the rail.
 - 2. Finish the sides of the 112 TRAM rail head to plus or minus 0.010 inch of the parent section. Grinding of the parent rail metal is acceptable as long as the minimum rail cross section is maintained.
 - 3. Finish the bottom of rail base, sides of the rail base, and outside faces of the rail flange and rail head to a finishing deviation of not more than plus 0.010 inch of

the parent section and minus no more than the minimum 112 TRAM rail cross section (For example rail base minimum dimension is 5.875 inches, grinding on side of rail base cannot cause the rail base dimension of the weld or the rail around the weld to be less than 5.875 inches)..

4. Finish the web zone to within 1/8 inch of the parent contour but not deeper than the minimum 112 TRAM rail cross section (see attached drawing for clarification of Web Zone for 112 TRAM rail). Finishing shall eliminate all cracks.
5. Alignment tolerances to be as specified in AREMA specification Sec. 4.2.2 Specification for Fabrication of Continuous Welded Rail.
6. Notches created by minor offset conditions, twisted or misshaped rails shall be eliminated by minimum grinding to blend the variations.
7. Fins on the weld due to grinding or shear drag shall be removed prior to final inspection.
8. Grind marks can be blended into the parent metal as long as 112 TRAM rail minimum cross sections are maintained.
9. Grind all sharp edges from welds to prevent damage to rail boot.
10. Finishing of 115 RE welds will follow Kansas City Downtown Streetcar Standard Specification requirements 34 11 16 3.8 B.

3.8 WELD QUALITY

- A. Inspect each "test and pressure weld" using the dry powder magnetic particle method in accordance with ASTM E709.
- B. Inspect each weld using a three foot straightedge along the centerline of the rail and 0.625 inch below top of rail on the gauge side of the rail head. Center the straightedge over the weld. The gap between the straightedge and the rail shall comply with the requirements of AREMA, Chapter 4.
- C. Ensure that each completed weld has full penetration and complete fusion and is entirely free of cracks or fissures.
- D. Porosity and slag-type defects will be acceptable provided that testing indicates that the largest defect does not exceed more than 3/16 inch in its largest dimension; the total area of the defect does not exceed 0.010 square inches, and the sum of the greatest dimension of defects in a line does not exceed 1/2 inch.
- E. Weld Hardness: As specified for the sample welds herein.

3.9 WELD NUMBERING

- A. Mark a sequential weld number on the rail immediately adjacent to the weld using a quality paint marker at the time the weld is made.
- B. Number welds sequentially in the order in which they are made.
- C. When defective welds are replaced assign a new sequential number to the new weld by adding a letter to the defective weld number.

3.10 FIELD QUALITY CONTROL

A. General:

1. Ultrasonically test all welds at the time of welding. Ultrasonic testing of the rail is not required.
2. Use equipment which has a distance amplitude correction feature.
3. Calibrate the equipment daily using an 11W calibration block, also made of rail steel.
4. Inspection Personnel: Qualify all inspection personnel in accordance with AWS D1.1/D1.1M.
5. Cut out and re-weld all welds giving fault indication in ultrasonic inspection using a minimum 19 foot piece of rail or cut out heat affected zone and pull together and re-weld.

B. Ultrasonic Weld Testing:

1. Mainline and yard field welds shall be ultrasonically tested (UT) over the entire cross section of head, web, and base. The UT equipment shall meet the requirements of AWS D1.1/D1.1M, Paragraph 6.17. The procedure shall meet the requirements of ASTM E164. Prior to performing production UT of welds, UT technicians shall demonstrate to the satisfaction of the Contracting Officer that they can discern and identify indication produced by slag, porosity, lack of fusion, and cracks. a. Use ultrasonic test equipment capable of detecting a 3/64 inch discontinuity, 6-1/2 inches below the top of rail. At a minimum, scan the weld from the top and both sides of the rail head and the base. Scan the weld from both sides on the face for longitudinal and transverse discontinuities using the applicable scanning pattern or patterns.
2. Testing Procedures: In accordance with the approved submittal.
3. Acceptance criteria shall be as follows:
 - a. Welds showing a response at any level that is identified as a crack or lack of fusion will not be acceptable.
 - b. Welds showing a response that is less than 50 percent of the primary reference level will be acceptable.
 - c. Welds showing a response greater than 50 percent but that do not exceed the primary reference level are acceptable, providing that all of the following apply:
 - 1) The defects are evaluated as slag or porosity.
 - 2) The largest defect does not exceed 0.180 inch in its largest dimension.
 - 3) The total area of the defects do not exceed 0.09 square inch.

- 4) The sum of the greatest dimension of defects in a line does not exceed 3/8 inch.
- d. Welds showing a response that exceeds the primary reference level will not be acceptable.

C. Magnetic Particle Testing:

1. Main line and yard field "test and pressure welds" shall be magnetic particle tested (MT). The procedures used shall meet the requirements of ASTM E709. Welds surfaces shall be tested except the underside of the rail base. The magnetizing equipment shall be an electro-magnetic yoke meeting the following requirements: a. DC lift capacity of 40 pounds, and/or b. AC lift capacity of 10 pounds at the maximum pole spacing.
2. Testing Procedures: In accordance with the approved submittal.
3. Acceptance Criteria: The weld quality shall meet the requirements of Paragraph 3.8.

3.11 DEFICIENT WELDS

A. Replacement of Defective Welds:

1. When the Contracting Officer determines a weld is unacceptable, cut out the weld and replace it with a 19 foot (minimum) rail plug.
 - a. Make saw cuts at least 6 inches from the centerline of the faulty weld.
 - b. Renumber replacement welds as indicated.
 - c. Ultrasonically test replacement welds made in rail as specified herein.
2. If one or both of the rails may be moved, cut out the weld, pull rails together to the indicated rail gap and reweld.
3. If neither rail may be moved, cut the weld out of the rail and replace with a section of new rail and with two new welds. Use a 19 foot minimum length of the new rail.

3.12 PROTECTION OF RAIL INSULATORS

- A. Rail insulators (pads, clips, insulators, and bushings) shall be covered/protected by a non-flammable material to prevent hot grinding fines from fusing into the rail insulating components.

3.13 WELD SLAG

- A. Welding fines and slag shall be removed from around the rails, insulating components, and the entire track area.

3.14 THERMITE WELD STAGGER

- A. Field welds in opposite rails shall be staggered a minimum of 5' for connecting CWR strings and a minimum of 2' at all other locations.

- B. Field welds shall not be located within 10' of a bolted rail joint.
- C. Field welds shall not be positioned within 3" of a support tie.

PART IV - MEASUREMENT AND PAYMENT

4.1 GENERAL

- A. The work specified in this section will not be measured separately for payment, but all costs in connection therewith will be considered incidental to track construction measured elsewhere.

SECTION 34 11 23
SPECIAL TRACKWORK

PART I - GENERAL

1.1 SUMMARY

- A. Description
1. This Specification defines the requirements for the design, detailing, manufacturing, fabricating, furnishing and delivery of the special trackwork.
 2. Special trackwork for this project shall consist of turnouts and all related equipment including switches and other track materials. All special trackwork shall have high-strength, head-hardened AREMA 115 RE rail in embedded track or on concrete slabs. Special trackwork shall include the following:
 - a. No. 4 turnouts with 115 lb. rail (115 lb. RBM frogs) on a concrete slab.
 - b. 25 M turnouts with 115 lb. rail (115 lb. RBM frogs) in embedded track.
 3. For Special Trackwork ties, see Contract Documents.
 4. The scope of work shall include all rail and associated components to include adapter plates for mounting switch machine rods. Supports and brackets for the switch machines shall be supplied by the switch machine manufacturer.

1.2 RELATED SECTIONS

- A. Section 34 11 00 – Rail
- B. Section 34 11 29 – General Track Construction
- C. Section 34 11 93 – Other Track Materials

1.3 REFERENCES

AREMA	American Railway Engineering and Maintenance-of-Way Association Manual for Railway Engineering, 2007 Edition
AREMA	American Railway Engineering and Maintenance-of-Way Association Portfolio of Trackwork Plans, 2007 Edition
ASTM	ASTM International, Current Editions
ANSI	American National Standards Institute, American National Standards Code, Current Edition

NEMA	National Electrical Manufacturers Association, Industrial Laminate Section Codes, Current Edition	
AREMA	Various	Manual for Railway Engineering
AREMA	Spec. 100	Portfolio of Trackwork Plans
ASTM	A27	Steel Castings, Carbon for General Application
ASTM	A47	Ferrite Malleable Iron Castings
ASTM	A128	Steel Castings, Austenitic Manganese
ASTM	A325	High-Strength Bolts for Structural Steel Joints
ASTM	A490	Heat-Treated Steel Structural Bolts
ASTM	B633	Electroplated Coatings of Zinc on Iron and Steel
ASTM	D149 Rev A	Standard Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies
ASTM	D217	Standard Test Method for Cone Penetration of Lubricating Grease
ASTM	D257	DC Resistance or Conductance of Insulating Materials
ASTM	D395	Standard Test Method for Rubber Properties in Compression Set
ASTM	D429	Rubber Property-Adhesion to Rigid Substrates
ASTM	D445	Rubber Test Method for Kinematic Viscosity of Transparent and Opaque Liquids
ASTM	D471	Rubber Property – Effect of Liquids
ASTM	D543	Standard Practices for Evaluating the Resistance of Plastics to Chemical Reagents
ASTM	D566	Standard Test Method for Dropping Point of Lubricating Grease
ASTM	D575	Standard Test Method for Rubber Properties in Compression

ASTM	D751	Standard Test Method for Coated Fabrics E1-1997
ASTM	D792	Standard Test Method for Density and Specific Gravity (Relative Density) of Plastics by Displacement
ASTM	D814	Standard Test Method for Rubber Property – Vapor Transmission of Volatile Liquids
ASTM	D1004	Standard Test Method for Initial Tear Resistance of Plastic Film and Sheeting
ASTM	D2231	Standard Practice for Rubber Properties in Forced Vibration
ASTM	D2240	Standard Test method for Rubber Property-Durometer Hardness
ASTM	D3083	Standard Specification for Flexible Poly (Vinyl Chloride) Plastic Sheeting for Pond, Canal, and Reservoir Lining
ASTM	D4833	Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products (E1-1996)
ANSI	B18.2.1	Square and Hex Bolts and Screws
ANSI	B18.21.1	Lock Washers
ANSI	B18.22.1	Plain Washers
NEMA	LI-1	Industrial Laminated Thermosetting Products

1.4 TESTING

- A. Except where specifically stated otherwise, all testing specified shall be undertaken by the Manufacturer. If the Manufacturer has previous or existing test results or certifications that are applicable, it may supply those subject to Engineer approval.

1.5 SUBMITTALS

- A. Submit or retain the following:
1. The Manufacturer shall submit separate shop drawings for each special trackwork turnout for review.
 2. Submit interface drawings addressing the attachment of the switch and detector rods to the special trackwork, prepared by the Manufacturer and approved by the Engineer.
 3. Retain full installation details and step-by-step procedures for installing the special trackwork in the field. The procedures also shall address the interface requirements for the installation of the switch machine.

1.6 TOLERANCES

- A. All fabrication tolerances shall conform with the track gauge of 4'- 8 ½", +/- 1/8", and a horizontal and vertical cross level tolerance of 1/16 inch.
- B. All component and fit tolerances shall meet the applicable requirements of AREMA Portfolio Drawings 1010 and 1011, and Specification 100.

1.7 COMPATIBILITY WITH SWITCH MACHINES

- A. Special trackwork and components shall be compatible with interface and operation of the designated switch machine manufacturer's model. Compatibility shall be confirmed by design and testing as specified herein.

1.8 SPECIAL TRACKWORK GEOMETRY

The following dimensions are fixed for each turnout as indicated on the Contract Drawings and may not be altered by the Manufacturer:

- A. Turnout Lead
- B. Length of switch alignment
- C. Radius of switch points
- D. Frog number
- E. Throw at point of switch
- F. Spread at heel of switch

PART II - PRODUCTS**2.1 RAIL**

- A. Rail for special trackwork, including stock rail and closure rail, shall be high strength and head hardened.
- B. Stock rails shall vary in length according to Special Trackwork Drawings (K3009 and K3010).
- C. Rails shall be cut square and clean by means of rail saws, shears or abrasive cutting wheels in accordance with the applicable current AREMA standards. All jointed rail shall be developed from one continuous rail section.
- D. Unless otherwise noted for thermite field welding, all rail ends shall be drilled for standard 6-hole joint bars in accordance with the current AREMA Manual for Railway Engineering, Rail Drillings, Bar Punchings, and Track Bolts. Holes drilled in the rails shall be peened or ground to remove all sharp edges, in reference to AREMA Table 4-3-1 and Figures 4-3-9 and 4-3-9.
- E. Curved rails (for curves with radius < 400 feet) shall be pre-curved in the shop by either gag press or roller bending methods. The rails shall be curved to true radius throughout the designated curve length and shall not exhibit visible kinks or tangents. Applicable insulated joints shall also be pre-curved.

2.2 SWITCH POINTS

- A. Switch points shall be as per the Special Trackwork Contract Drawings. Switch points shall have reinforcing bars attached by square-head bolts and hex nuts. Reinforcing bars shall be 1/2 inch thick and double-reinforced, as per AREMA Portfolio Plan 221.
- B. Alignment of switch points shall be as per AREMA drawings with extended length for the installation of floating heel blocks. Switch point length currently is set as per the Contract Drawings. Manufacturer may substitute alternatives subject to the Engineers approval.
- C. Switch points shall have an undercut design in accordance with AREMA Plan Basic Number 221, Detail 5100. Switch point stops shall bear against the supporting stock rails when points are in the thrown positions.
- D. All switches shall be installed for interlocked power operation.

2.3 HEEL BLOCKS

- A. AREMA 11' straight and 13' curved switch points shall have heel-joint assemblies as per AREMA Plan 221. AREMA switch points of 16'-6", 19'-6", and 26'-0" shall have floating heel block assemblies. Contractor shall consider alternate designs according Contract Drawing K3405 or approved Shop Drawing substitute.
- B. The floating heel block on the straight side of the turnout (curved switch point) shall consist of cast steel, Class B.
- C. At locations where a restraining rail in the crotch area between the stock rail and the closure rail extends to the heel block, the heel block shall incorporate a flangeway flare design to maintain the curve guarding for the longest possible distance. Material for such heel blocks shall be cast manganese steel.

2.4 RAIL BRACES AND SLIDE PLATES

- A. Ballasted turnouts on concrete ties shall accommodate a boltless brace design per Contract Drawings K3022.

2.5 GAUGE PLATES – NOT USED

2.6 TURNOUT FROGS

- A. Turnout frogs shall be fabricated to the designated turnout number geometrics and shall be solid manganese steel frogs in accordance with AREMA Plans 622-03, 623-03 or 624-03; or spring frogs in accordance with AREMA Plan 401-03 or as applicable, and as designated on the Contract Drawings.
- B. Austenitic manganese steel castings shall be of a heavy wall thickness design in accordance with the requirements of AREMA Plan Basic Number 100, Section M2.2, and ASTM A128, Grade A. Castings shall be explosive depth hardened in accordance with AREMA, *Specifications for Special Trackwork*, Article M2.7, with a minimum Brinell hardness of 350. Hardening shall project uniformly to 250 BHN at a depth of 11/8 inches.
- C. The Manufacturer shall produce shop drawings to specify the procedures to be used for the depth hardening process, the portions of each frog which are to be depth hardened, and the Brinell hardness pattern which the Manufacturer anticipates to achieve with such procedures.

2.7 FROG GUARD RAIL

- A. Frog guardrail shall consist of a tee rail design with single piece construction and level guardrail height. The ends of the guardrail shall be beveled and milled. The flangeway shall be the minimum width required for the proposed AAR 1B wheel profile. Foot guards shall be provided. For details, refer to Contract Drawings.

2.8 TIE PLATES – NOT USED**2.9 TURNOUT PLATES**

- A. Turnout plates shall be designed to accommodate the required turnout geometry and for use with an elastic rail clip system with welded on shoulders. The plates shall be insulated as required to conform with system electrical isolation requirements.

2.10 SWITCH RODS

- A. Switch rods shall be vertical insulated switch rods.
- B. Prior to assembly of insulated joints, the mating surface and ends of switch rods, steel channel, and splice plates shall be coated with an approved insulation enamel. The assembled joints shall be dielectrically tested to verify that insulated joints can withstand a potential of 1,500 volts dc for one minute without evidence of flashover, pinholes, or fracture.
- C. Switch Rod Insulation shall be as per AREMA C&S Requirement for insulation.

2.11 TRACK CROSSINGS – NOT USED**2.12 LUBRICATION**

- A. Lubricant for moving parts in turnouts shall meet the following requirements:
- | | | |
|----|--|---------|
| 1. | Calcium soap | 9% |
| 2. | Graphite | 11.5% |
| 3. | Penetration, ASTM D 217 at 70 ⁰ F worked | 340 |
| 4. | Dropping Point, ASTM D 566 at 77 ⁰ F | 101/214 |
| 5. | Oil viscosity, ASTM D 445, cSt at 104 ⁰ F | 81.8 |
- B. Other types of lubricants may be used providing that the lubricant has been used successfully by other rail agencies, and subject to the Engineers written statement of no objection.

2.13 RAIL JOINTS

- A. Rail joints for special trackwork shall be thermite welded or by means of joint bars. Where a joint occurs in a guarded rail section of the turnout, a separator block shall be provided for the full length of joint bar in between the two rails.
- B. Joint bars and separator blocks shall meet the requirements specified in Section 02459.

- C. Insulated joints shall meet the requirements specified in Section 02459. Insulated joints located in single rails shall be of an epoxy glue design. Insulated joints located in guarded rail sections shall be a poly-encapsulated design.
- D. All bolted joints shall be a minimum length of 36" and have six bolts.

2.14 SWITCH TIES – NOT USED

PART III - EXECUTION

3.1 DETAILED DESIGN

- A. The Manufacturer shall develop all required details in accordance with these specifications and good practice. Detailed shop drawings shall be provided by the Contractor for all components including but not limited to frogs, switches, closure rails, restraining rails, rail fastener plates, and fastener layouts. The Contractor shall address the following considerations in the design of special trackwork:
 - 1. Rail Lengths - Design layouts with rails that are to be left longer than the theoretical length shown on the Contract drawings and with blank (non-drilled) ends so that such rails can be cut and drilled in the field to compensate for accumulated construction tolerance deviations in assembly of the layouts.
 - 2. Dimensions - All dimensions shall be confirmed in the field with respect to locations where the new special trackwork must tie into existing tracks. The location of existing joints and the amount of wear on existing rails shall be determined so that the location of joints can be detailed on the shop drawings.

3.2 SHOP ASSEMBLY FOR DOUBLE CROSSOVERS & RR CROSSING – NOT USED

3.3 HANDLING AND DELIVERY

- A. All rails and special trackwork shall be handled carefully and delivered in open top containers to avoid damage by kinking, bending, nicking, or other potential damage to the rail. Rails and special trackwork components shall not be dropped or struck sharply. Handling and delivery shall be in accordance with accepted industry practice.
- B. Stock rails, closure rails, tongue rails, and frogs shall be delivered assembled with associated fasteners attached.
- C. All bundles, boxes and kegs shall be clearly marked with the following information:
 - 1. Identification of items contained
 - 2. Supplier's name
 - 3. Delivery date
 - 4. Number of pieces
 - 5. Gross weight

3.4 ACCEPTANCE

- A. Acceptance is subject to inspection upon delivery.

PART IV - MEASUREMENT

- 4.1 Item Basis** – Measurement of the turnouts will be per each turnout supplied and installed.

PART V - PAYMENT

- 5.1 General** – The accepted measured quantity of each pay item will be paid for at the Contract unit price per unit of measurement. The Contract unit price will be payment in full for furnishing all labor, materials, tools, equipment and incidentals, and doing all Work necessary to complete the Work specified.

END OF SECTION

SECTION 34 11 29**GENERAL TRACK CONSTRUCTION****PART I - GENERAL****1.1 SUMMARY**

A. Description:

1. This section specifies general track construction which consists of the mainline and yard trackwork indicated on the plans including installing direct fixation track, ballasted track, embedded/paved track, special trackwork, and track appurtenances.

1.2 REFERENCES

A. American Railway Engineering and Maintenance-of-Way-Association (AREMA):

1. AREMA - "Manual for Railway Engineering" (AREMA Manual)
2. AREMA - "Portfolio of Trackwork Plans"

B. ASTM International (Formerly known as American Society for Testing and Materials) (ASTM):

1. ASTM A 123-Standard Specification for Zinc (Hot dip Galvanized) Coatings on Iron and Steel Products.
2. ASTM 0570-98 (2010) e1 – Standard Test Method for Water Absorption of Plastics
3. ASTM D638-10 – Standard Test Method for Tensile Properties of Plastics
4. ASTM D3786 - Standard Test Method for Hydraulic Bursting Strength of Textile Fabrics-Diaphragm Bursting Strength Tester Method
5. ASTM D4318-10 - Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
6. ASTM D4491-99a (2009) - Standard Test Methods for Water Permeability of Geotextiles by Permittivity
7. ASTM D4533-11 - Standard Test Method for Trapezoid Tearing Strength of Geotextiles
8. ASTM D4632 - Standard Test Method for Grab Breaking Load and Elongation of Geotextiles
9. ASTM D4751-12 - Standard Test Method for Determining Apparent Opening Size of a Geotextile
10. ASTM D4833 - Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products
11. ASTM D5199-12 - Standard Test Method for Measuring Nominal Thickness of Geosynthetics
12. ASTM E10-12 - Standard Test Method for Brinell Hardness of Metallic Materials

- C. American Public Transportation Association (APTA):
 - 1. APTA - "Guidelines For Design of Rapid Transit Facilities" (APTA Guidelines)
- D. The Society for Protective Coatings (Formerly known as Steel Structures Painting Council (SSPC)):
 - 1. SPCC-SP 1 – Solvent Cleaning
- E. American Association OF State and Highway Transportation Officials (AASHTO)
- F. Kansas City Metropolitan Chapter of the American Public Works Association (APWA)

1.3 DEFINITIONS

- A. Approach Slab: A reinforced concrete slab located at the interface of ballasted track with direct fixation track or paved track to provide a transition between ballasted track construction and the types of track with significantly higher track modulus.
- B. Ballast: An integral part of the track structure, generally composed of crushed stone in which ties are embedded. Track ballast includes ballast compacted beneath the ties, in the cribs between the ties, and in the ballast shoulders at the ends of the ties.
- C. Bumping Post: A device placed at the end of stub-end tracks to prevent a moving rail vehicle from inadvertently rolling off the end of the track.
- D. Closure Rails: The rails between the parts of any special trackwork layout, such as the rails between the switch and the frog in a turnout; also the rails connecting the frogs of a crossing or of adjacent crossings, but not forming parts thereof.
- E. Continuous Welded Rail (CWR): A number of rails welded together into a single length.
- F. Crossing, Road: The intersection of one or more tracks and a street, road, or highway, at grade.
- G. Crossing, Railroad: The intersection of two tracks, at grade, consisting of four frogs, also known as a "diamond".
- H. Crosslevel: The difference in elevation of the tops of heads of opposite rails measured at right angles to the track alignment.
- I. Crossover, Single: Two turnouts with the track between the frogs arranged to form a continuous passage between two nearby and generally parallel tracks.
- J. Crossover, Double: Two crossovers which intersect between the connected tracks.
- K. Crossover, Universal: Two single crossovers, one being right hand and the other left hand, joining two nearby parallel tracks. The two single crossovers are located in close proximity to one another and typically are operated by the same signal interlocking.
- L. Frog: A device used at the intersection of two running rails to provide support for wheel treads and passageways for their flanges, thus permitting wheels traversing either rail to cross the other left hand, joining two nearby parallel tracks. The two single crossovers are located in close proximity to one another and typically are operated by the same signal interlocking.

- M. Frog Number: The number used to designate the size of a frog, and being equal to one-half the cotangent of one-half the frog angle.
- N. Grade Line: The line on the profile representing the top of the roadbed ready to receive the sub-ballast at the intersection of the roadbed with a vertical plane through the track center line.
- O. Guard Rail: A rail or other device laid parallel with the running rails of a track to prevent wheels from being derailed; or to hold wheels in correct alignment to prevent their flanges from striking the points of frogs. A rail or other device laid parallel with the running rails of a track to keep derailed wheels adjacent to running rails.
- P. Inside Rail: On curved track, the rail closest to the curve center, the rail with the shorter radius. Sometimes referred to as the "low rail".
- Q. Joint Bar: A steel member, embodying beam-strength and stiffness in its structural shape and material; commonly used in pairs for the purpose of joining rail ends together, and holding them accurately, evenly, and firmly in position with reference to surface and gauge-side alignment.
- R. Outside Rail: On curved track, the rail farthest from the curve center; the rail with the longer radius. Sometimes referred to as the "high rail".
- S. Pocket Track: A track located between the two mainline tracks on which an out-of-service train may lay over or reverse direction.
- T. Profile Grade Line (PGL): The datum line which defines the vertical alignment of the track, applied at the top of the low rail.
- U. Rail Fastening - Ballasted Track: A resilient device used to secure the running rail to the concrete tie at the proper track gauge to provide proper vertical, lateral, and longitudinal restraint of the rail.
- V. Rail Fastener - Direct Fixation Track: A resilient device used in track to secure the running rails to concrete in tunnels, cut and cover structures, aerial structures, and slab track at the proper gauge to provide proper vertical, lateral, and longitudinal restraint of the rail. Also known as direct fixation fasteners or DF fasteners.
- W. Rail Joints: A fastening designed to unite the abutting ends of contiguous rails.
- X. Rail Joint, Insulated: A rail joint designed to arrest the flow of electric current from rail to rail by means of insulation so placed as to separate the rail ends and other metal parts connecting them. Commonly called insulated joints or "IJ's".
- Y. Restraining Rail: A guard rail installed parallel to, concentric with, and on the gauge side of the inside running rail of curved track with a flangeway of approximately 2-1/8 inches. It extends into the tangent track on each end of the curve, bears against the back side of the wheels, and steers the inside wheels of each truck around the curve, thereby reducing the degree of contact of the leading outside wheel flange with the outside rail. It also reduces gauge wear on the outside running rail.
- Z. Roadbed: The foundation (prepared subgrade) on which the track structure consisting typically of sub-ballast and ballast is placed.

- AA. Special Trackwork: A generic term referring to turnouts, single and double crossovers, track crossings, and other such items.
- BB. Standard Rail: A synonymous term to 115 RE rail.
- CC. Stock Rail: A running rail against which a switch rail bears in a turnout.
- DD. Stub-up: A conduit temporarily terminated in the roadbed for later use by signal, communication, or traction power installers.
- EE. Sub-Ballast: A material which provides a semi-impervious layer between the finished subgrade of the roadbed and the ballast, to provide better drainage, prevent upheaval by frost, and better distribute the load over the roadbed.
- FF. Subgrade: The finished surface of the roadbed below the level of sub-ballast or track slab.
- GG. Superelevation: The vertical distance of the outer rail of a curve above the inner rail. It is provided to overcome or partially overcome the effects of curvature and speed.
- HH. Switch, Point of: The tip of the tapered end of a switch rail; the end of a switch rail farthest from the frog or heel block.
- II. Switch Point, Undercut: A switch point planed to mate with a stock rail having a planed undercut, in order to provide an effective point width of zero.
- JJ. Switch Rail (Switch Point): A planed, tapered, movable rail which mates with a stock rail to enable movement of a train from one track to another.
- KK. Switch, Split: The common type of track switch consisting essentially of two planed, movable switch rails.
- LL. Top of Rail (T/R): The top surface of the head of the running rail.
- MM. Track, Ballasted: Track constructed of rails, crossties, and ballast. It is the predominant form of track constructed at-grade, but it is also used on short bridges.
- NN. Track, Direct Fixation: Track constructed of rail and rail fasteners attached by means of anchor bolts to concrete, located in tunnels, cut and cover structures, aerial structures, and slab track.
- OO. Track, Embedded (Paved): Track constructed on a track slab and, except for the flangeways, embedded in asphalt, concrete, paving blocks, rubber epoxy, or other such material to the elevation of the top of rail.
- PP. Track, Gauge: The distance between the inside faces of running rails at right angles measured at a point 5/8 inch below the top of rail. Standard gauge: 4 feet 8-1/2 inches.
- QQ. Track, Mainline: A track designated by route name and direction, and which is for the purpose of carrying revenue passengers.
- RR. Track, Secondary and Yard: Track constructed for the purpose of switching, storing, or maintaining rail vehicles or connecting such tracks to mainline tracks.
- SS. Trackway: The foundation on which the track is constructed. It usually consists of an earthen roadbed, but it may also be one of the following: a concrete roadbed for support of

direct fixation track or paved track; a ballasted bridge deck (designed to receive ballast); or an aerial structure.

- TT. Turnout: An arrangement of a switch and a frog with stock rails and closure rails, enabling rail vehicles to be diverted from one track to another.
- UU. Turnout Number: The number corresponding to the number of the frog used in the turnout.
- VV. Zero Thermal Stress: The state of uniform stress in CWR, while the rail is unrestrained and free to move longitudinally.
- WW. For additional definitions, refer to AREMA Manual and Portfolio of Trackwork Plans.

1.4 SUBMITTALS

- A. Shop Drawings, include the following:
1. General plan for distributing CWR, including:
 - a. Storage location upon delivery and prior to installation.
 - b. General layout of CWR site.
 2. Complete details of the proposed methods, including equipment, of laying and fastening CWR. Include method and equipment proposed for achieving zero thermal stress.
 3. Description of temperature adjustment and final anchoring procedures for CWR, including charts, tables, and field instructions on heating, cooling and stretching.
 4. Charts shall be provided that indicate gaps for varying lengths of rail and varying rail temperatures.
- B. Procedures: Provide complete details of the end-hardening procedures, including identification of personnel to perform the procedure, the equipment, and the test results required no less than 30 days prior to initiating any end-hardening.
- C. Installation Procedures: Prepare and submit a description of the procedures and methods to be employed in the construction of embedded track. At a minimum, include the following:
1. The methods of placing rail, supporting structures, and concrete to produce finished track meeting the alignment requirements within the specified tolerances.
 2. The procedure for handling, installing, and field welding continuous welded rail..
 3. In accordance with the requirements of APWA 2703, "Special Aggregate Concrete – Bridge Deck, Sidewalk, Barriers and Curbs, Diaphragms, and Approach Slab", including:
 - a. Procedures for forming, mixing, placing, and curing of concrete.
 - b. Proposed concrete and joint materials; include packing, storing, handling, proportioning, additives, mixing, and placing details.

4. The method of ensuring that the rail and supporting structure are not dislocated during placement of concrete.
 5. The procedures for erecting the support beams and securing the rail.
 6. Procedures for installation of track drain components.
 7. Procedures for installing the rail boot, including splices, and boot clips.
 8. Quality control procedures to ensure proper installation.
- D. Track equipment to be used on Roadbed: Submit weights and dimensions of track equipment proposed for use on roadbed prior to employ it on roadbed.
- E. Rail Mounted or Hi-Rail Construction Equipment: Submit a complete list of track equipment for use during trackwork construction, within 30 days after receipt of the Notice to Proceed. Include rail-mounted geometry inspection vehicle.
1. Equipment to be utilized shall not exceed design clearance envelope and loading criteria for the Streetcar System.
 2. Submit a complete description of all proposed modified equipment, including calculations verifying that loading criteria for the light rail system will not be exceeded.
 3. Certify that the equipment modifications will clear all structures and other facilities at the areas where the equipment will be used.
 4. Certify rail wheels are in good condition, without excessive wear. Damage to frogs, crossing panels, etc. shall be repaired or replaced as determined by the City.
- F. Product Data: Submit manufacturer's data for Contractor-furnished material including non-woven filter fabric and adhesive for bonding tags to concrete. Submit installation information and sufficient description to verify that materials comply with the specifications. Include specification data and manufacturer's installation instructions for non-woven filter fabric. Submit product data for support beams and associated hardware, rail boot, and slab joint materials.
- G. Mix Design: Submit concrete mix design as specified in APWA 2703, "Special Aggregate Concrete – Bridge Deck, Sidewalk, Barriers and Curbs, Diaphragms, and Approach Slab"
- H. Certification: Certification of concrete mix design, reinforcement, and bonding agents.
- I. Samples: Submit sample for non-woven filter fabric.
- J. Test Reports: Submit summaries of test results each week for field weld tests, Brinnell Hardness Tests, insulated joint continuity tests, track geometry vehicle measurements, and any other periodic testing required by Contract. If there was no activity during the week, submit each summary noting no activity.
- K. Rail Laying Record: Submit records in accordance with Article 3.14 D. herein.
- L. Submit manufacturers' rail specifications to the Authority for approval.

1.5 QUALITY ASSURANCE

- A. Comply with:
 - 1. Codes and regulations of the jurisdictional authority.
 - 2. APTA Guidelines.
 - 3. AREMA Manual.

1.6 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. City-Furnished Material:
 - 1. None.
- B. Contractor-Furnished Material: Supply track construction material indicated in the Contract Documents.

1.7 MONUMENTATION AND SURVEYING

- A. Monuments will be provided by the City to establish the centerlines of tracks as specified in Section 01 71 23, "Field Engineering".
- B. The Contractor shall set monuments at all points as shown on the Contract Drawings.
- C. The Contractor shall be responsible for the preservation of all Geographic Reference Stations, State of Missouri and City of Kansas City Missouri maintained benchmarks, section corners, property monuments of any kind and other reference marks set by the City or any other governmental authority as shown on the plans or informed of in writing in accordance with Section 01 71 23, "Field Engineering".
- D. Do not use controls for surveys other than the monumentation described above unless otherwise approved by the Contracting Officer.
- E. Perform surveying required herein in accordance with Section 01 71 23, "Field Engineering". Assume full responsibility for all dimensions and elevations taken and the setting of lines and grades relating thereto.

PART II - PRODUCTS

2.1 CITY FURNISHED MATERIALS

- A. None.

2.2 CONTRACTOR FURNISHED MATERIALS

- A. Concrete Materials:
 - 1. Provide concrete reinforcement as specified in Section 03 20 00, "Concrete Reinforcing".
 - 2. Track slab concrete shall be as specified in Section 502 of the Missouri Standard Specifications for Highway Construction, "Portland Cement Concrete Pavement" or approved equal.

- B. Rail Support Structure:
 - 1. Provide steel support beams.
 - 2. Include leveling screws, rail clips, and other accessories as recommended by the support beam manufacturer.
 - 3. Where necessary, provide 4" X 4" x 3/16" bearing plates fabricated of ASTM A36 steel or equivalent.
- C. Rail Boot
 - 1. Provide extruded rubber rail boot as recommended by manufacturer. The rail boot shall be fabricated to fit 115RE or 112 TRAM rail.
 - 2. Provide splices for the rail boot as required, fabricated to be compatible with the rail boot. Include all required splice materials as recommended by the boot manufacturer to fully isolate the rails electrically.
- D. Track Drains
 - 1. Provide track drains fabricated of materials approved by the Authority. Include appropriate end panels, outlets, and grates. Furnish devices as necessary to secure the grates to the troughs.
 - 2. Where embedded track is in shared right-of-way, track drain grate and frames must be traffic rated (HS20-44 loading). Steel angle support and bolting of grating to angles shall be strong enough and designed to transfer HS20-44 loading into the concrete slab.
 - 3. Rail must be isolated from track grate, frame, and any other metal items.

2.3 METAL TAGS

- A. For ballasted track, provide aluminum or brass identification tags stamped in 1/4 inch increments from zero superelevation to maximum superelevation to mark the superelevation on curved track. These tags shall be 1-1/4 inches wide by 2 inches long by 0.050 inch thick, and stamped with numerals 1/2 inch high.
- B. Adhesive for Bonding Tags to Concrete: As proposed by the Contractor and approved by the City.

2.4 RAIL

- A. Tee-rail: 115 RE section either standard or premium rail in accordance with the requirements of AREMA "Specifications for Steel Rails" and as specified.
- B. Block rail: 112 TRAM – Low profile (72mm) higher strength rail (grade S900/R260).

2.5 TIES

- A. Ballasted trackwork construction shall consist of concrete crossties, unless otherwise shown on plans or in the special provisions.

- B. Concrete crossties: 8 feet 3 inches in length unless specified elsewhere conforming to AREMA "Specifications for Concrete Ties". Concrete ties shall be prestressed monoblock concrete. Type to be used shall be shown on the Contract Drawings.
- C. Concrete switch ties of varying lengths conforming to AREMA "Specifications for Concrete". Concrete ties shall be prestressed monoblock concrete. Type used shall be as shown on Contract Drawings.
- D. Concrete ties for at-grade road crossings shall be 10 feet in length conforming to AREMA "Specifications for Concrete".

PART III - EXECUTION

3.1 GAUGE

- A. Measure the track gauge between points 5/8 inch below the top. For tee rail, measure perpendicular to and from inside face to inside face of the running rails. For 112 TRAM rail, measure from outside face of groove to and from outside face of groove.
- B. Tangent and curved track gauge:
 - 1. 4 feet 8-1/2 inches for tee rail.
 - 2. 4 feet 8-1/2 inches for 112 TRAM rail in tangent and curves greater than 150' radius.
 - 3. As specified by plans for curves 150' or less radius track.
- C. Special trackwork track gauge (tee rail): 4 feet 8-1/2 inches. Special trackwork manufacturer shall conduct a wheel/rail study to verify gauge and include with trackwork submittal for engineer's review.
- D. Allowable gauge variation:
 - 1. Ballasted mainline track: plus or minus 1/8 inch.
 - 2. Direct fixation mainline track: plus or minus 1/8 inch.
 - 3. Paved mainline track: plus or minus 1/8 inch.
- E. Gauge Transition: The plans shall outline the method for transitioning between gauges of different widths.

3.2 ALIGNMENT

- A. Alignment consists of a series of straight lengths of track referred to as tangents, connected by simple, compound or reverse curves, with or without spirals.
- B. The track shall be constructed to the alignment and profile indicated on the plans, within the tolerances specified in Table 34 11 29-1.
- C. Use outer rails of curves as the line rail. Either rail may be used as the line rail in tangent; however, use that same rail for the full length of that tangential segment of track.
- D. The ends of the chord to be at points on the gauge side of the line rail 5/8 inch below the top of the rail head.

- E. In addition to the requirements specified:
 - 1. Place the track in good alignment before the finishing lift is made.
 - 2. Follow immediately behind the finishing lift with a mechanical means of lining the track and line to accurate alignment. Typically line and surface in the same operation, but the finishing lift may include adjustments to “accurate alignment”.

3.3 SURVEYING REQUIREMENTS

- A. Refer to Section 01 71 23, ‘Field Engineering’.
- B. Verify layout information shown in relation to the existing City-provided monuments and existing structures before proceeding with layout of the actual work. As the work proceeds, check every major element of work for line. Bring discrepancies in location of structures to the attention of the City before starting trackwork. Maintain an accurate surveyor's field book of such checks; make available for the City's reference. Record deviations which are accepted by the City on the Record Drawings.
- C. Verify the actual grade line and the profile of the top of the sub-ballast. Variations from the design grade line and profile shall meet tolerances specified in Section 01 71 23, ‘Field Engineering’.
- D. Furnish and place markers for the control points and reference points of the track centerlines, as indicated. Stake centerlines at station platforms, grade crossings, and bridge structures for inspection by the City.
- E. Upon completion of the project, the Contractor shall provide the City with all original surveying field notes, layouts, and computations in standard bound survey books. The Contractor shall also provide the City all electronic files, code libraries, CAD drawings and any other files or documents, whether electronic or paper, that are part of the survey work. Point code files shall be submitted in raw data file format and plain text ASCII, comma or space delimited format having one record of point number, northing, easting, elevation and point code (in that order per line). All electronic files must be submitted in an uncompressed file format on a USB flash drive or CD-ROM disk. Individual electronic files shall not span multiple disks. All disks shall be labeled with the City project number, project location, date (month and year) of the survey and disk number if more than one as required under Section 01 71 23, ‘Field Engineering’.
- F. Maintain control points and reference points for the duration of the project.

3.4 SUPERELEVATION, SPIRALS, AND CURVATURE

- A. Superelevation:
 - 1. Superelevate mainline track curves as indicated.
 - 2. Maintain superelevation uniformly over the length of curve or as otherwise shown.
 - 3. Superelevate the outer rail above the inner rail; install the inner rail at the required profile indicated.
- B. Spirals: Establish the superelevation at the point of tangency at zero and increase the superelevation uniformly through the length of the spiral to full elevation of the outer rail at the spiral-to-curve point. Install the spiral at the ends of simple curves and segments of compound curves as indicated.

- C. Curvature: Curve information shall be as shown. Shop fabricated rail shall be marked by the manufacturer for installation.

3.5 TRACK SURFACE

- A. Track surface is the relationship of opposite rails to each other in profile and crosslevel:
 - 1. Track profile is the running surface along the top of the grade rail.
 - 2. The ideal surface is a uniform profile consisting of straight gradients connected by vertical curves, with zero crosslevel on tangents, and predetermined crosslevel on curves.
 - 3. Do not raise the profile of track being surfaced above established grades.
 - 4. When surfacing or raising track, select one rail, usually the lower rail on curves and the line rail on tangents, as the grade rail. Bring the other rail to surface by adjusting the crosslevel as needed.

3.6 SUBGRADE PREPARATION

- A. Place and compact the required depth of subgrade material as specified in Section 32 11 00, "Base Courses". Reference shall also be made to the project Geotechnical Report and details in the plans.

3.7 CONCRETE PLACEMENT

- A. Place concrete in accordance with the requirements of Section 03 20 00, "Concrete Reinforcing", and Section 502 of the Missouri Standard Specifications for Highway Construction, "Portland Cement Concrete Pavement".
- B. During placement of reinforcing steel and concrete use care to avoid disturbance of the support structure, rail, boot, track drains, and associated hardware. Contractor is to take measures to prevent uplift during the concrete pour.

3.8 TRACK DRAINS

- A. Install track drain components in accordance with the plans and/or supplier's recommendations.
- B. Brace track drains with temporary supports to maintain correct position during concrete placement.
- C. Cover track drains during concrete placement to prevent concrete from entering the trough.

3.9 SUPPORT STRUCTURE

- A. Install the rail support structure as recommended by the support beam supplier. Place a bearing plate below each adjusting screw. In areas of sloped subgrade, create a flat area in the subgrade slightly larger than the bearing plate.
- B. Space beams according to the details in the plans.
- C. Adjust the support beams to the required elevation prior to placing rail.

3.10 RAIL INSTALLATION

- A. Place rail strings on the support beams and install the rail boot on the rail. Apply the rail clips loosely using procedures recommended by the supplier.
- B. Where rail will require field welding, place rail boots no closer than ten feet to the proposed weld. Field weld CWR as specified in Section 34 11 16, "Trackwork - Field Rail Welding".
- C. Prior to placing concrete, join rail strings and adjust the jacking screws and tighten rail clips to bring rails to correct grade and alignment. Complete installation of the rail boot and verify the correct installation of all boot splices.

3.11 RAIL

- A. Follow plans or track charts in determining exact location and lengths of premium and standard rail.

3.12 CUTTING AND DRILLING RAIL

- A. Use only the following tools for cutting rail:
 - 1. Rail saw.
 - 2. Abrasive cutting wheels.
- B. Drill holes:
 - 1. When necessary, drill new holes; do not punch, slot, or burn with a torch.
 - 2. Drill holes 1-1/8 inch in diameter; locate as indicated.
 - 3. Drill with the joint bars removed or before their application. Mark the location of the center of the hole, or drill through an approved template. Do not drill bolt holes using the joint bars as a template.
 - 4. When bolt holes are drilled with a power track drill, maintain a uniform feeding pressure. Reduce pressure as the bit point breaks through the opposite side of the web. Do not force the drill.
 - 5. Remove all rough edges from drilled rail holes.
 - 6. Do not leave bolt holes in the ends of rail to be welded.
 - 7. Reaming or enlarging incorrectly drilled holes to allow joint bar bolts to be installed will not be permitted. Rejected holes shall be sawcut from the rail.
 - 8. Torch cuts or blown holes will not be acceptable.
 - 9. Rail strings have handling holes. These holes shall be cropped before welding.

3.13 RAIL JOINTS

- A. Either weld or bond rail joints as indicated.
- B. Field weld rails in accordance with Section 34 11 16, "Trackwork - Field Rail Welding".

- C. Install bonded joints where indicated in accordance with the requirements of this section and Section 34 11 93, "Other Track Materials".
- D. Install joints in track that is in final horizontal and vertical alignment with ballast tamping completed.

3.14 LAYING CONTINUOUS WELDED RAIL

- A. Unload and lay CWR in a place and in a manner that prevents damage to the ties, rails, and structures.
- B. Lay opposite CWR strings in a manner which results in a 5 foot minimum stagger of welds.
- C. Make every effort to minimize or eliminate field cuts and field welds in CWR. Designate location in finished track by route name, stations of ends of rail string, and right or left rail as determined by facing in the direction of increasing stationing. Place all rail numbers on the same side of the CWR string.
- D. Record the following information at the time of laying the rails on the crossties or DF plinth and again at the time of anchoring CWR. Furnish copies of this documentation to the City.
 - 1. Location by station, track designation, and rail.
 - 2. Date and time.
 - 3. Rail weight and section, mill brand, year rolled, and the heat number of the end rails in each CWR string.
 - 4. Length of CWR string in feet.
 - 5. The following temperatures, at the beginning of the activity and again at the end of the activity:
 - a. Ambient temperature.
 - b. Rail temperature.
 - 6. Approximate weather conditions.
 - 7. Adjustment applied (type and rail end movement).
- E. Between the time of laying the rail (placement on the ties) and anchoring the rail, the Contractor shall monitor rail temperatures and adjust each Dutchman as required to avoid rail buckling or rail end batter.

3.15 RAIL TEMPERATURE

- A. Determine rail temperature by means of an AREMA standard rail thermometer as specified in the AREMA Manual.
 - 1. Place rail thermometers on the shaded side of the rail base next to the web and leave in place until no change in its reading is detected, but not less than five minutes.
 - 2. Take rail temperature at the time of adjusting the gap between rail ends.

3.16 DESTRESSING RAIL

- A. Rail zero stress (neutral) temperature at final closure and fastening shall be $75^{\circ}\text{F} \pm 10^{\circ}\text{F}$ ($24^{\circ}\text{C} \pm 5^{\circ}\text{C}$).
- B. The rail shall have a uniform longitudinal stress along the entire fastened length (except at free ends).
- C. The Contractor shall submit a detailed procedure for achieving uniform longitudinal rail stress for the zero stress temperature specified herein.
- D. Final closure shall be by field weld with the rail fully fastened (except immediately adjacent to the field weld as necessary to perform the weld) near or at final elevation and alignment. If post closure rail realignment is required, the Contractor shall provide sufficient longitudinal restraint either side of the location of realignment to assure the rail stress state is not changed by the realignment Work.

3.17 TEMPORARY FASTENING

- A. Temporarily fasten track for use of on-track equipment.
- B. Prior to equipment being placed on newly laid rail, secure the rail in a manner that will prevent damage to the CWR, rail fasteners, and other track materials.
- C. Move equipment over newly laid rail in such a manner as to prevent damage to trackwork materials.
- D. Temporarily fasten newly laid rail on ballasted track at not less than:
 - 1. Every third tie on tangents and on curves having a radius greater than 1,900 feet.
 - 2. Every other tie on curves having a radius of 1,900 feet or less.
- E. Do not field weld or bond between contiguous CWR strings and between CWR strings and special trackwork units before the rail has been brought to final vertical and horizontal alignment, before the rail has been adjusted to the indicated zero thermal stress range, and before the rail has been fully fastened.

3.18 PERMANENT RAIL FASTENING

- A. Adjust the CWR string lengths for the specified zero thermal stress temperature:
 - 1. Adjust rail on DF bridges before adjusting ballasted track approaches. Anchor 300 track feet on each side at the temperature specified for DF track. When adjusting the approaches, unclip the 300 ballasted track feet up to the structure and adjust the ballasted track string to the appropriate temperature for ballasted track.
 - 2. When closing on a fully anchored string, remove 300 feet of existing rail clips, readjust the existing string for temperature and refasten before executing the field weld.
 - 3. Fasten the CWR strings in a manner which ensures that there is no unfastened portion of rail greater than 100 feet in length between fastened portions of the same string.

4. When joining newly constructed track to existing track in operation, adjust the adjacent 300 track feet of the existing track for zero thermal stress temperature in conjunction with the de-stressing of the new track.
 5. Obtain approval of the City prior to de-stressing existing track in operation. De-stressing work of operating track shall not be scheduled during streetcar operating hours.
- B. Vibrate the rail to relieve internal rail stresses and fully fasten the string. Record movement at quarter points and submit to the City daily.
1. Use vibrators, approved by the City, to relieve internal rail stresses.
 2. Do not strike CWR with objects which might damage the rail surface.
- C. Temperature of a rail, when being fastened opposite a previously fastened rail, shall be within 5 degrees F of the previously fastened rail's temperature at the time of its fastening.
- D. Once the rail has been adjusted to achieve zero thermal stress at the specified temperature, maintain the correct rail gap until the rail is fully fastened.

3.19 ZERO THERMAL STRESS

- A. Zero thermal stress at the specified temperature in CWR may be achieved by heating, cooling, or pulling the rails, or a combination thereof. When zero thermal stress at the specified temperature is obtained, begin fastening immediately.
- B. Maintain the stress within the rail to achieve the specified zero thermal stress range during installation of joints.

3.20 FIELD WELDING

- A. Perform field welds in accordance with the requirements of Section 34 11 16, "Trackwork - Field Rail Welding".

3.21 RAIL END-HARDENING

- A. End-harden standard rail ends in the field at all bonded joints. Remove joint bars from rail ends during the end-hardening process.

3.22 END-HARDENING TESTS

- A. Personnel to perform end-hardening shall prepare two sample rails in accordance with the AREMA Manual.
1. Test the two samples through an independent laboratory approved by the City and submit the test results to the City.
 2. Acceptance of the end-hardening procedure and personnel will depend on the samples passing the tests specified below.
- B. Two samples of end-hardened rail shall be tested for Brinell hardness in accordance with ASTM E10 in a grid pattern of 1/4-inch increments for a distance of 6 inches from the end of the rail.
- C. Record the Brinell hardness numbers and locations.

- D. After the hardness test has been performed, section one sample longitudinally for 1 foot along the centerline of rail. The other sample shall be sectioned transversely 1/2 inch from the end of the rail. Etch both cross sections to facilitate the observation of the hardness pattern.
- E. Attain a Brinell hardness number not less than 341 nor more than 401 when measured at a point on the centerline of rail 1/2" from the rail end. The decrease in hardness shall occur uniformly over a distance not less than two inches. The hardness pattern shall be uniform across the top surface of the rail head. Examine the etched cross sections of the rail to ensure that a uniformly distributed hardness pattern is evident. End hardening shall be performed only by personnel and with procedures which have been accepted in accordance with the above procedure.

3.23 RAIL BEVEL

- A. Bevel rail ends at bonded joints in accordance with AREMA Standard Plan Basic Number 1005.

3.24 RAIL GRINDING

- A. Upon completion of the track by the Contractor to the specified tolerances and after acceptance, rail grinding will be done by the City.

3.25 FINAL ALIGNMENT AND TRACK INSPECTION

- A. Survey the track in accordance with Section 01 71 23, "Field Engineering", to determine if the horizontal and vertical alignment, gauge, crosslevel, and superelevation are within the tolerances specified for each type of track construction.
- B. Correct track deviations which exceed tolerances.

3.26 ELECTRICAL TESTS

- A. Electrical Test.
 - 1. The insulated joint assembly shall be dry. Apply 500 volts d.c. across the joint from rail to rail and from each rail to one bar, each arrangement for a duration of 5 seconds. Use a megohmmeter that reads directly in megaohms to measure resistance.
 - 2. The acceptance criterion for this test shall be a minimum resistance of 10 megaohms.
- B. The Contractor shall submit test procedures and equipment identification for the Engineer's review at least 30 Days prior to beginning Work. The electrical test shall be performed by a certified electrician employed by the Contractor and approved by the Engineer.
- C. Results of the electrical test shall be submitted to the Engineer for approval.
- D. Any single bonded insulated joint that fails the electrical test in track shall be removed, replaced and retested at Contractor's expense. Replacement procedure shall be approved by the Engineer.

3.27 PRECURVED RAIL

- A. Install fabricated precurved rail as shown and in accordance with the approved manufacturer's fabrication drawings.
- B. Mark precurved radius and installation location.

3.28 RESTRAINING RAIL

- A. Install fabricated restraining rail as shown and in accordance with the approved manufacturer's fabrication drawings.

PART IV - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT AND PAYMENT

- A. Plan quantities are final quantities; no field measurement will be made.

TABLE 34 11 93-1

TRACK CONSTRUCTION TOLERANCES

Class and Type of Track	Gauge Variation	Cross Level and Superelevation Variation	Vertical Track Alignment		Horizontal Track Alignment	
			Total Deviation	Middle Ordinate In 62' Chord	Total Deviation	Middle Ordinate In 62' Chord
Direct Fixation and Paved Track	+1/8" - 1/16"	± 1/8"	± 1/4"	± 1/8"	± 1/8"	± 1/8"
Mainline Ballasted Track	± 1/8"	± 1/8"	± 1/2"	± 1/8"	± 1/2"	± 1/8"
Yard Ballasted Track	+3/16" - 1/8"	± 3/16"	± 3/8"	± 1/4"	± 3/8"	± 1/4"
Shop Track	± 1/8"	± 1/8"	± 1/4"	± 1/8"	± 1/4"	± 1/8"

Notes:

- (1) Total deviation is measured between the theoretical and actual alignment centerline at any point in the track.
- (2) Total horizontal and vertical deviation in road crossings ± 1/4".
- (3) In the Station Platform areas: Total Horizontal deviation shall be 0" towards Platform and 1/8" away from platform; Total Vertical deviation shall be 0" above Platform and 1/8" below platform.

END OF SECTION

SECTION 34 11 93**OTHER TRACK MATERIALS****PART I - GENERAL****1.1 SUMMARY**

A. Description

This Section defines the requirements for the manufacture, testing, and supply of insulated joint bars, compromise joints, shims, miscellaneous hardware for fastening of running rail and special trackwork. All hardware shall be new and sized to match the fastener component for which they will be used.

1.2 REFERENCED STANDARDS

A. Insulated Joints and Compromise Joints

<u>Sponsor</u>	<u>Number</u>	<u>Subject</u>
AAR	Part 58	Signal Specification
AAR	Part 116	Signal Specification
AREMA	Chapter 4-Section 3.8	Specifications for Bonded Insulated Rail Joints
AREMA	Chapter 4-Section 3.4	Specifications for Quenched Carbon steel Joint Bars and Forged Compromise Joint Bars
ASTM	E165-02	Standard Test Method for Liquid Penetrant Examination
ASTM	A194/A194M-13	Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Service
ASTM	F436-11	Standard Specification for Hardened Steel Washers
ASTM	A490-12	Standard Specification for Structural Bolts, Alloy Steel, Heat Treated, 150 ksi Minimum Tensile Strength
ASTM	A325-10e1	Standard Specifications for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ISO	9001:2008	Quality Management Systems-Requirements
ASTM	D1002-10	Standard Test Method for Apparent Shear Strength of Single-Lap-Joint Adhesively

Bonded Metal Specimens by Tension Loading

SSPC SP-10 Near-White Blast Cleaning

B. Shims

<u>Sponsor</u>	<u>Number</u>	<u>Subject</u>
ASTM	A653/A653M-11	Standard Specification for Steel Sheet, Zinc-Coated or Zinc-Iron Alloy-Coated by the Hot-Dip Process

CSA	G40.21-04	Structural Quality Steels General Instruction
-----	-----------	---

CSA	G164-M92 (R2003)	Hot-Dip Galvanizing of Irregularly Shaped Articles
-----	------------------	--

ISO	9001:2008	Quality Management Systems-Requirements
-----	-----------	---

C. Miscellaneous Hardware

<u>Sponsor</u>	<u>Number</u>	<u>Subject</u>
ASTM	B633-13	Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel

1. Bolts and nuts shall conform to:

<u>Sponsor</u>	<u>Number</u>	<u>Subject</u>
AREMA	Chapter 4 Section 3.3	Rail Drillings, Bar Punching, and Track Bolts
AREMA	Chapter 4 Section 3.5	Specifications for Heat-Treated Carbon-Steel Track Bolts and Carbon-Steel Nuts

2. Spring washers shall conform to:

<u>Sponsor</u>	<u>Number</u>	<u>Subject</u>
AREMA	Chapter 4 Section 3.6	Specifications for Spring Washers

D. Bumping Posts

<u>Sponsor</u>	<u>Number</u>	<u>Subject</u>
ISO	9001:2008	Quality Management Systems-Requirements

AWS	D1.1	Welded Steel Construction (Metal Arc Welding)
-----	------	---

1.3 SUBMITTALS

A. Submit or retain the following:

1. Insulated Bonded Joints and Compromise Joints
 - a. Submit detailed description of the adhesive to be used to bond the joint bars to the rail, and the method by which the quality of the adhesive formulation and preparation is regulated, maintained and monitored.
 - b. Retain drawings showing details of bolts, lock nuts and all other components of the assembly, including fully detailed step-by-step installation instructions.
 - c. Submit inspection and test plan
 - d. Retain packaging procedures
 - e. Retain most recent historical rolling load test records demonstrating adherence to these Specifications.
 - f. List of references and contact personnel of transit authorities that have qualified and accepted similar concrete guard rail ties for Contracts with similar technical specifications.
 - g. Statement of the manufacturer's capabilities to carry out the work in accordance with the technical and quality assurance/control requirements.
 - h. Delivery procedures
 - i. Testing facilities certifications
 - j. Insulated rail joint electrical test procedures and equipment
 - k. Insulated rail joint electrical test results
2. Shims
 - a. Inspection and test plan and procedures
 - b. Retain packaging procedures
 - c. Delivery procedures
3. Miscellaneous Hardware
 - a. Retain shop drawings detailing the hardware to be furnished for the Work
 - b. Submit prequalification test results for review or prequalification test plans to include:
Test procedures
 - i. Schedule of qualification tests to be performed
 - ii. Name of independent test laboratory proposed to perform tests
 - c. Retain production run test plans to include:
 - i. Test procedures
 - ii. Test reporting procedures

- d. Retain hardware manufacture quality assurance reports to include:
 - i. Production run test reports
 - ii. Packaging procedures

1.4 QUALITY ASSURANCE/QUALITY CONTROL

A. General

The Contractor shall include its inspection and testing plan for the work. The inspection and testing plan shall identify who, what, when and where in the process of design, production, assembly, shipment and acceptance that all inspections will be performed.

- B. The Contractor shall conduct review of fabrication drawings, showing the details and procedures for the manufacture, cutting of the plates, machining of the inclined surfaces, drilling, punching or cutting of holes, and the finishing to specified tolerances prior to commencement of fabricated work.

PART II - PRODUCTS

2.1 MATERIALS

A. Insulated Bonded Joints

Insulated Bonded Joints shall be in accordance with Section 2.8 and Section 2.11 of the AREMA Manual for Railway Engineering, Chapter 4 and as directed below. The Contractor shall furnish single bonded insulated rail joints, in kit form, of the epoxy bonded type as manufactured by L.B. Foster Allegheny Rail Products, Co., Portec Rail Products Inc., Railway Bonded insulated joints, or approved equal.

Joint bars for insulated bonded joints shall provide for full face contact, conforming to the shape of the designated TRAM or RE rail section, and shall be fabricated from quenched carbon steel as specified in the AREMA specifications, except as defined herein. The joint bars shall be smooth and straight for installation along tangent track, or pre-curved to match the rail radius at the connection point of special trackwork and in curves with a radius less than 400 feet.

The fishing height of the joint bars shall be within a tolerance of + 0 inches to $1/32$ inch of the dimensions defined in the AREMA specifications. The contact surface of the joint bars adjacent to the rail shall be smooth and straight within a tolerance of $\pm 1/32$ inch using a 36 inch straight edge. The inside face of the joint bars shall be smooth, with no stamping or branding permitted.

Insulated bonded joints shall be complete with 3/16" thick high pressure laminated end posts, steel core bushings, and heat-treated oval neck track bolts, nuts, and washers. Nuts shall be designed with a locking feature to prevent loosening meeting Contract requirements.

Provide holes in the rail and joint bars as required. The size and location of deburred holes shall conform to the AREMA Manual for Railway Engineering, Volume 1, Chapter 4 Rail, Section 1.3 Rail Drillings, Bar Punchings and Bolts.

The structural adhesive used as the bonding agent shall produce a minimum lap shear strength of 3,500 psi at 75 degrees F as per test prescribed in ASTM D1002. Adhesive and electrical insulation materials supplied with the joint bars shall have a shelf life of not less

than one year when stored in a location protected from the weather. A corrosion inhibitor shall also be included in the adhesive formulation.

The insulating materials shall consist of a high pressure and laminated design; impervious to oil, grease, and water; and having electrical resistance characteristics equal to or greater than fiber insulation meeting the requirements of the AREMA Signal Manual of Recommended Practice, Sections 8.5.2 Recommended Developmental Criteria for Fabricated Insulating Parts for Track Insulation and 8.5.3 Recommended Developmental Criteria for Track Insulating Material; and the Electrical Resistance Test specified herein.

B. Compromise Joints

New compromise joint bars shall conform to the requirements of the "Specifications For Quenched Carbon-Steel Joint Bars and Forged Compromise Joint Bars" found in Chapter 4, Part 2 of the AREMA Manual for Railway Engineering.

Compromise joint bars shall be of the size, shape, and punching pattern required to fit the rail sizes and sections being joined. Only factory designed and forged or cast compromise joint bars shall be used.

TRAM rail compromise transition pieces shall be machined to smoothly transition from an RE section to TRAM section. Contractor to submit shop drawings for review.

C. Shims

Regular and tapered steel shims used to adjust the elevation of the direct fixation fasteners shall be manufactured to the shape, size and configuration to accommodate the direct fixation fastener system. The tapered shims shall be used to adjust rail cant transition from 1:20 to zero at the special trackwork areas and to maintain the required rail cant at grade crossings.

Steel shims specified to the thickness of 20 gauge and 11 gauge shall be manufactured from galvanized steel, coating designation G90, meeting the requirements of ASTM A653M, lock forming quality or approved equivalent.

Steel shims specified to the thicknesses of $\frac{1}{8}$ inch, $\frac{3}{8}$ inch, $\frac{1}{2}$ inch and all tapered shims shall be manufactured from hot-rolled plate steel meeting the requirements of CSA G40.21, Grade 260 or equal. The measured thickness shall be inclusive of galvanizing. Steel shims shall be hot-dip galvanized in accordance with the latest edition of CSA G164, or equal. Galvanizing of shims shall consist of a minimum coating of 2 ounces/ft² on each side after manufacture.

Steel shims shall be sheared or cut by a method to obtain the required configuration, and which is acceptable to the buyer. Edges sheared, punched or cut during manufacture shall be ground to remove all sharp edges. Shims are to be hot dipped galvanized after all machining is complete. Slotted or circular holes shall be drilled, punched or cut at right angles to the shim surfaces.

Steel shims shall be smoothly finished and free from injurious warp and other surface imperfections due to projecting fins of metal caused by shearing, drilling or punching operations.

D. Miscellaneous Hardware

All miscellaneous hardware shall meet the physical dimensions, strength and properties and test requirements as defined herein.

The hex head bolts shall be used for embedding into concrete with or without epoxy grout and shall consist of the minimum dimensions required for the particular use. The hex head bolt shall be capable of withstanding the ultimate torque requirement necessary to destroy the diameter bolt as specified in ASTM A325. The ultimate tensile strength of the hex head bolt itself shall equal or exceed the tensile strength of 56,380 pounds as specified in ASTM A325.

Circular holes for joint bolts shall be drilled to conform to the drawings. A variation of nothing under and $\frac{1}{16}$ inch over in the size of the bolt holes will be permitted. A variation of $\frac{1}{32}$ inch in the location of the holes will be permitted. Chamfer the entrance and exit sides of the holes.

Miscellaneous heat-treated carbon-steel track bolts and carbon-steel nuts shall be in accordance with Section 2.9 of the 2006 AREMA Manual for Railway Engineering. Miscellaneous spring washers shall be in accordance with Section 2.10 of the 2006 AREMA Manual for Railway Engineering.

PART III – EXECUTION

3.1 QUALIFICATION TESTING

A. Insulated Bonded Joint Bars

Six (6) samples of the designated RE rail section will be prepared for qualification testing. Four (4) of the pieces shall be 24 inches long and two (2) of the pieces shall be 36 inches. All qualification testing will be performed at the expense of the Contractor.

1. End Hardening Tests

All six (6) samples shall be end hardened in accordance with the Contractor's submitted procedure. Two (2) sample ends shall be selected and tested as specified below:

- a. Brinell hardness readings will be taken at the centerline of the rail head longitudinally at $\frac{1}{4}$ inch intervals for a distance of one inch from the hardened end. The rail sample shall then be sawed longitudinally along the centerline and the Brinell hardness readings shall be taken at $\frac{1}{4}$ inch intervals, $\frac{3}{16}$ inch below head of rail, for a distance of 2 inches from the hardened end. The de-carburized surface on the rail head shall be removed before taking Brinell hardness readings.
- b. Acceptance shall be based on a Brinell hardness measured at a spot on the center line of the head between 341 and 401 at all locations within $\frac{1}{2}$ inch of the rail end. The heat-affected zone defined as the region in which the hardness is above that of the parent metal shall cover the full width of the rail head and extend longitudinally a minimum of 1.5 inches from the end of the rail. The effective hardness zone $\frac{1}{2}$ inch from the end of the rail shall be at least $\frac{1}{4}$ inch deep.
- c. If either of the samples fails to meet the acceptance criteria, the procedure shall be modified and the tests repeated until acceptance hardness values have been achieved.

2. Longitudinal Compression Test

Two bonded joints shall be completely assembled, by others, from the four sample pieces of RE rail each 2 feet long. Each joint assembly shall then be sawn in half

where the rails are butted together. The sawing shall be performed in a manner which will prevent overheating and damage to the epoxy bond, and the cut will be perpendicular to the centerline of the top of the rail with a tolerance of +/- one degree. The sawn ends of the bars at one end of the test piece, and the end of rail at the other, shall have fair bearing in the test machine to ensure that the loading and reaction are through the centroid of the rail, and parallel to its axis. Loads shall be applied longitudinally in increments of 25,000 pounds. Each load increment shall be maintained constant until the longitudinal deflection of the rail ceases before increasing the load to the next increment. The load will be increased in these designated increments until a total load of 600,000 pounds is attained, or failure occurs. At each increment of loading, the load and differential movement of the rail and joint bars, measured to 0.001 inch, shall be recorded.

The bonded joint shall be accepted based on the Longitudinal Compression Test when it is demonstrated that the joints have not slipped at any time during application of the incremental loads, up to 600,000 pounds, nor the magnitude of differential movement is $\frac{1}{16}$ inch in any direction. At the completion of the test, after the load on the rail has been released, the relative position of the rail and joint bar shall be within 0.020 inch of its original position.

If either sample fails to meet the above-defined requirements, the installation procedure shall be modified and the tests repeated.

3. Electrical Resistance Test:

a. Test Procedure:

- i. Fully assemble an insulated rail joint consisting of two lengths of 115 RE rail; one 24 inches long and the other 42 inches long. The rail shall be supported on non-conducting material.
- ii. 500 volts (DC) shall be applied to the rail across the insulated joint for a duration of 3 minutes, while the current flow through the joint is measured and recorded to the nearest 0.1 microampere.

b. Acceptance Criteria:

- i. The minimum resistance shall be 10 megohms for 500 volts (DC).

4. Rolling Load Test:

After completion of the Electrical Resistance Test, the same bonded joint shall be subjected to the Rolling Load Test per Section 2.11.7.4 of the 2006 AREMA Manual for Railway Engineering.

If the sample fails to meet the above defined acceptance test requirements, the installation procedure shall be modified and the tests repeated.

5. Additional Follow-up Testing:

a. Test Procedure:

- i. The bonded insulated joint shall be subjected to follow-up testing after it has passed the electrical resistance test, electrical impedance test and the rolling load test.

- ii. Repeat the electrical resistance and impedance tests as specified above.
 - iii. Subject the joint assembly to the Longitudinal Compression Test after completion of the electrical resistance and impedance tests.
 - b. Acceptance Criteria:
 - i. The follow-up testing results shall follow the acceptance criteria previously established for each respective test.
- B. Shims
 - 1. Prototype Testing

Prototypes of each designated type of steel shim shall be manufactured, tested and supplied to the UTA for review and written statement of no objection prior to the start of production.

The prototype testing shall include checks of all dimensions, coating thickness, and surface finish for each type of shim specified.
 - 2. Production Testing

The Contractor shall submit mill certificates defining the chemical and mechanical properties of the material supplied for the manufacture of the steel shims.

Dimensional measurements shall be performed by the Contractor to ensure conformance with the specifications. At least 2% of all the shims manufactured for the project and not less than 2 shim types manufactured per production day. Test results shall be submitted to the UTA for review.

The coating thickness of shims galvanized by the Contractor or its agent shall be verified by the Contractor using magnetic gauges or by a procedure acceptable to UTA. Tests on the coating thicknesses shall be performed on at least 1% of all the shims produced for the project and on not less than 1 shim type per production day. Certified test results shall be submitted to the UTA for approval.
- C. Miscellaneous Hardware
 - 1. Hardware Production Test Requirements

The Contractor shall submit mill certificates on the chemical and mechanical properties of the material supplied for the manufacture of the hardware.

The hex head bolts and lag screws shall be subjected to and meet the pre-qualification test acceptance criteria as specified in ASTM A325.

The hex head bolts and lag screws shall be subjected to and meet the production run test acceptance criteria as specified in ASTM A325.
 - 2. Coating

All hex head bolts shall be coated in accordance with ASTM B633, Type II (Olive Drab) Fe/Zn.

All other designated hardware shall be galvanized in accordance with the applicable ASTM specifications.

3.2 PACKAGING, LABELING, AND STORAGE

A. Insulated Bonded Joint Bars

1. Packaging

All materials used for packaging and crating for delivery shall be new, robust and of equal quality to the best commercial packaging and delivery crating practices accepted in the industry.

The choice of packaging shall be based on the most severe operational and climatic conditions expected during transit and storage. Key factors to be considered shall include the following:

- a. Possibility of rough handling during transit and storage from manufacturer to final destination.
- b. Shock, vibrational and static impacts, and environmental exposure during loading, unloading and transit operations.
- c. Geographic and climatic conditions at the final destination.
- d. Handling facilities and practices used at points of loading and discharging of cargo.

2. Labeling

Each package unit shall be marked to identify contents, quantity, and gross weight.

B. Compromise Joint Bars

Compromise joint bars shall be wired together in pairs and separated from the other bars.

C. Shims

Shims shall be packaged by the category of thickness, handled and stored in a manner that will prevent damage to the materials. The Contractor's commercial practice for preservation and packaging shall provide adequate protection against deterioration and physical damage during storage and handling.

Shipment marking information shall be provided on the interior and exterior of delivery containers. The information shall include nomenclature, manufacturer's name and part catalog number, contract or order number, and destination.

D. Miscellaneous Hardware

The hardware shall be manufactured, transported and stored so that no physical damage occurs to the threads. The hardware shall be packaged in equal quantities and in accordance with commercial practice for preservation and packaging.

Shipment marking information shall be provided on the exterior of delivery containers. The information shall include nomenclature, manufacturer's name and part catalog number,

contract or order number, and destination. Each pallet shall not exceed 2000 pounds in weight and each pallet shall clearly show the quantities on each pallet.

3.3 INSTALLATION OF BONDED INSULATED RAIL JOINTS

- A. Each crew and its foreman shall be pre-qualified before installing each type of glued joint. In order to become pre-qualified, a crew must fabricate two joints in track to simulate actual joint installation and then cut the joints out of the track. The joint will then be tested in accordance with the Longitudinal Compression Test. Failure of a test sample disqualifies the foreman and, at the discretion of the Engineer, the entire crew.
- B. All non-high strength 112 TRAM and 115 RE rail shall be hardened and all rail ends shall be beveled in accordance with AREMA Standard Plan No. 1005-40-Beveling of the Rail Ends for Special Trackwork. Remove all foreign materials, loose rust, and scale to near white metal on the end 21 inches of the web, bottom of head and top of base of each rail in accordance with SSPC SP-10.
- C. Field fabricated single bonded insulated joints shall be installed at locations shown on the Contract drawings and in conformance with the manufacturer's recommended procedures. Two insulated joints, on opposite rails, shall be installed at each callout on the respective Plan, unless otherwise indicated.
- D. The center of the joint shall be approximately centered between rail supports and the contractor shall alternate the direction of the bolt insertion.
- E. The Engineer shall be notified 24 hours in advance of installation of all insulated joints.
- F. Installation procedures shall be submitted for the Engineer's review at least 30 days prior to beginning Work and shall include at least the following items:
 - 1. Care and storage of materials
 - 2. Date of glue manufacture
 - 3. Glue shelf life
 - 4. Rail end preparation
 - 5. Weather and temperature restrictions
 - 6. Mixing and application of glue
 - 7. Installation of insulated joint bar and pin bolts
 - 8. Curing restrictions
 - 9. Detection of glue bond failures
- G. Insulated Rail Joint Electrical Test
 - 1. All insulated joints shall be tested after installation into track.
 - 2. Electrical Test
 - a. The insulated joint assembly shall be dry. Apply 500 volts DC across the joint from rail to rail and from each rail to one bar, each arrangement for a duration of 5 seconds. Use a megohmmeter that reads directly in megohms to measure resistance.
 - b. The acceptance criterion for this test shall be a minimum resistance of 10 megohms.

3. The Contractor shall submit test procedures and equipment identification for the Engineer's review at least 30 Days prior to beginning Work. The electrical test shall be performed by a certified electrician employed by the Contractor and approved by the Engineer.
 4. Results of the electrical test shall be submitted to the Engineer for approval.
 5. Any single bonded insulated joint that fails the electrical test in track shall be removed, replaced and retested at Contractor's expense. Replacement procedure shall be approved by the Engineer.
- H. Insulating paint shall be applied to the circumference of the rail head and post after assembly and curing of bonded insulated joint adhesive. The insulating paint shall be applied as a stripe centered on the end post 1", \pm 1/4" wide.
- I. Rail cuts and end drilling shall conform to the requirements in Section 34 11 29, "General Track Construction".

PART IV - MEASUREMENT

- 4.1 Item Basis** – Measurement of the transition rails and insulated joints will be per each item supplied and installed. No separate measurement will be made for the other track materials required for the track construction.

PART V - PAYMENT

- 5.1 General** – The accepted measured quantity of the transition rails and insulated joints will be paid for at the Contract unit price per unit of measurement. The Contract unit price will be payment in full for furnishing all labor, materials, tools, equipment and incidentals, and doing all Work necessary to complete the Work specified. Cost for the other track materials than those listed above will be incidental to the Contract unit cost of the Embedded Track bid items.

END OF SECTION

SECTION 34 21 05**COMMON WORK RESULTS FOR TRACTION ELECTRIFICATION SYSTEM (TES)****PART 1 - GENERAL****1.1 SUMMARY**

- A. This Section includes the following:
 - 1. Summary of Work for TES.
 - 2. General electrical requirements for materials, assembly, and installation.
 - 3. Labeling and listing of electrical equipment and products, and field evaluation for products not listed.
 - 4. Delivering, picking, and setting prepackaged TES substations on site.
 - 5. Coordinating with Kansas City Power & Light (KCP&L) for TES substations.
 - 6. Temporary power for TES substation HVAC.
- B. Requirements of this Section apply to all 34 21 xx and 34 22 xx sections.

1.2 RELATED SECTIONS

- A. SECTION 01 33 00 – Submittal Procedures
- B. SECTION 34 21 06 – TES Common Work Results for Metals
- C. SECTION 34 21 17 – TES Substation Design and Assembly
- D. SECTION 34 21 31 – TES Substation Automation System (SAS)
- E. SECTION 34 22 05 – TES Common Work Results for Conductors and Cable

1.3 DEFINITIONS

- A. Authority Having Jurisdiction (AHJ): As defined in NFPA 70, Article 100, Definitions.
- B. Engineer: Owner's representative.

1.4 REFERENCED STANDARDS

- A. Institute of Electrical and Electronics Engineers (IEEE)
 - 1. IEEE C2, National Electrical Safety Code
- B. International Conference of Building Officials
 - 1. International Building Code (IBC)
- C. National Electrical Contractors Association (NECA)
 - 1. NECA 1, Standard Practice of Good Workmanship in Electrical Construction

- D. National Electrical Manufacturers Association (NEMA)
 - 1. NEMA 250, Enclosures for Electrical Equipment (1000 Volts Maximum)
- E. National Fire Protection Association (NFPA)
 - 1. NFPA 70, National Electrical Code (NEC)
 - 2. NFPA 130, Fixed Guideway Transit and Passenger Rail Systems

1.5 SUBMITTALS

- A. Procedures: SECTION 01 33 00 – Submittal Procedures.
- B. TES Specific Requirements:
 - 1. Schedule submittals such that the project schedule is not delayed.
 - a. Submit product data and samples not less than 30 days before scheduled procurement. Submit shop drawings not less than 30 days before work involving such drawings is to be performed.
 - b. Contractor shall bear the risk when products, equipment, or materials are procured before approval of submittals or work is started before approval of shop drawings.
 - 2. On each submittal, indicate the relevant Specification Section by section number, paragraph number, and subparagraph number.
 - 3. For submittals requiring resubmittal, resubmit with title identical to the original submittal and clearly indicate the revision number.
 - 4. Stamp and sign submittals as reviewed and approved by the Contractor before submission, including subcontractor submittals.
- C. Product Data: Submit manufacturer's product data for products specified in this Section if not submitted under another Section:
 - 1. Sealing strip.
 - 2. Padlocks.
- D. Schedule of padlocks with keying.
- E. Submit for information only:
 - 1. Substation setting plan, including diagram showing position of truck and crane and description of steps involved.
 - 2. Substation anchoring design sealed by a structural engineer registered in the State of Missouri.
- F. Seismic Calculations: Submit sealed seismic design and bracing calculations that include equipment and raceways in each Section of these Specifications.

1.6 COORDINATION

- A. Coordinate delivery of prefabricated substation with Engineer.
 - 1. Before picking substation off truck, obtain approval to partially or completely restrict a city street, sidewalk, or alley with Kansas City.
- B. Electric Utility, Kansas City Power & Light (KCP&L):
 - 1. Contact KCP&L to obtain KCP&L-furnished metering equipment:
 - a. Meter socket.
 - b. CTs and PTs.
 - 2. Coordinate with KCP&L for connection of permanent power to substations. Provide access to allow KCP&L to install service conductors in Contractor-provided conduit. KCP&L will terminate conductors.
 - 3. Owner will pay utility bill for permanent power at each substation from the time of connection of permanent power.

1.7 QUALITY ASSURANCE

- A. Comply with the requirements of the Project Quality Plan.
- B. Regulatory Requirements: Comply with current federal, state, and local requirements.
- C. Compliance with Standards:
 - 1. Where equipment or materials are specified to conform to the standards of organizations such as ANSI, ASTM, IEEE, and NEMA, submit evidence of conformance for review and record purposes.
 - 2. The label or listing will be acceptable as sufficient evidence that the materials and equipment do conform to the specified standards.
 - 3. Wherever a code or standard is specified, it shall be understood that amendments to the specified standard by the state, county, city, or other authority having jurisdiction shall apply to the Work.
 - 4. Submit evidence of compliance to seismic safety requirements of the International Building Code and NFPA 70.
 - 5. Perform Work in compliance with the following industry standards and regulations:
 - a. NFPA 70, National Electrical Code .
 - b. NFPA 130, Standard for Fixed Guideway Transit and Passenger Rail Systems.
 - c. NECA 1, Standard for Good Workmanship in Electrical Construction.
 - d. IEEE C2, National Electrical Safety Code.
- D. Qualifications:
 - 1. Workers shall be experienced in the type of work they are performing.

2. TES Substation: Modifications or testing performed in substations after delivery to the site shall be supervised by a TES Substation Supervisor representing the substation manufacturer. The supervisor must be located at the site, not at a remote location.
 3. Welding: Performed only by welders qualified as stated in Section 34 21 06, TES Common Work Results for Metals.
 4. Ensure workers performing field work meet the qualification and licensing requirements of the State.
- E. General Performance Requirements:
1. Provide electrification equipment proven in similar railroad, rail transit, or heavy industrial service and make use of this experience to prepare a suitable and proven design for this application.
 2. Systems Integration: Integrate TES elements such that specified requirements are achieved without conflict or error within or between specified elements.
 3. Provide replacement spare parts that are functionally and physically interchangeable for each product class.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Obtain written permission from the Engineer before shipping substation.

PART 2 - PRODUCTS

2.1 TRACTION ELECTRIFICATION SYSTEM (TES) SUMMARY OF WORK

- A. Assemblies, Material, Equipment, Products, Installation, and Related Submittals:
1. Four prefabricated TES mainline substations and one built-in-place TES Vehicle Maintenance Facility (VMF) substation.
 2. Grounding for TES substations at each substation site.
 3. Grounding for surge arresters at each substation site.
 4. Blue lights on TES substations and OCS poles.
 5. Dc positive feeder cables from each substation to the OCS.
 6. Dc negative cables from each substation to the rail.
 7. Cross bonding cables.
 8. Fiber optic cables between TES substations for transfer trip.
 9. Pad-mounted dc disconnect switches at each substation.
 10. VMF dc disconnect switches.
 11. VMF contactor panel and interlocking.
 12. VMF Auxiliary Power Supply (APS), with ac disconnect switch, control panel, and APS cable with attachment plug.

13. TES spare parts and special tools.
- B. Coordination with Kansas City Power & Light (KCP&L).
- C. Special Submittals:
 1. TES Studies.
 2. TES Operation & Maintenance Manual.
 3. As-built drawings.
 4. TES Training Manual.
- D. Testing of TES substations, cable, and other installed equipment and systems.
- E. Training of Owner's personnel.

2.2 SEISMIC DESIGN

- A. Equipment provided under this Contract shall meet seismic requirements specified in the International Building Code (IBC).
- B. Submit calculations and design for suitable anchorage and bracing performed and sealed by a structural engineer registered in the State of Missouri.

2.3 MATERIALS AND PRODUCTS

- A. General Requirements:
 1. Material shall be new and in first class condition, of design, sizes, and ratings as indicated, and suitable for the use intended.
 2. Products shall be the manufacturer's latest standard design and discontinued materials or products shall not be used.
 3. Materials and equipment shall be standard products of manufacturers regularly engaged in the production of such material and equipment.
 4. Methods of fabrication, assembly, and installation shall comply with specified standards.
 5. Where two or more units of the same class of material or equipment are required, provide products of a single manufacturer.
 6. Similar component parts of different larger assemblies are not required to be the products of the same manufacturer.
 7. Each type of material and equipment shall be of the same manufacture and quality throughout the Work.
- B. Environmental Requirements:
 1. Material and equipment shall be designed to ensure satisfactory operation and life in the environmental conditions that exist where the material or equipment is installed.

2. Material and equipment shall be suitable for its intended environment.
 - a. Wet locations: NEMA 250 Type 4X corrosion resistant stainless steel enclosures.
 - b. Indoor damp locations: NEMA 250 Type 12 enclosures fabricated from painted-galvanized or stainless steel.
 - c. Wet or damp locations: Corrosion resistant fittings or supports, hot-dip galvanized or as otherwise specified.
 - d. Exposed dry locations: Corrosion resistant painted finishes may be used for equipment and enclosures as approved by Engineer.
- C. Finish Requirements:
 1. Ferrous Metal: Above Grade: Hot-dip galvanized, galvanized, or powder coated. Refer to Galvanizing or Shop Applied Coatings in Section 34 21 06, TES Common Work Results for Metals.
 2. Galvanizing: Wherever "galvanized" or "hot-dip galvanized" is called out in these Specifications, the material shall be coated in accordance with galvanizing requirements in Section 34 21 06, TES Common Work Results for Metals.
- D. Fasteners, Hardware:
 1. Fasteners: Stainless steel. Double-sided tape shall not be used for attachment of channel or wire supports.
 2. Hardware:
 - a. Corrosion resistant.
 - b. Suitable for the use and environment intended by the manufacturer.
 - c. Unplated steel shall not be used.
- E. Cable ties (tie wraps): Comply with requirements of Section 34 22 05, TES Common Work Results for Conductors and Cable.
- F. Sealing Strip: Water and humidity resistant moisture barrier.
 1. Neoprene rubber pad, durometer hardness Shore A 60, tensile strength 900 psi, elongation 300 percent, 1/4 inch by 6 inches.
 2. Acceptable Manufacturer/Product: Biltrite Commercial Neoprene, Style 10.
- G. Field Applied Coatings:
 1. Galvanized Steel Field Coating: Organic cold galvanizing coating as specified in Section 34 21 06, TES Common Work Results for Metals.
 2. Oxide inhibiting joint compounds:
 - a. Non-petroleum based compound with evenly suspended zinc particles.
 - b. Approved Manufacturer/Product: Burndy, Penetrox A-13, or approved equal.

2.4 POLE-MOUNTED BLUE LIGHT

- A. Comply with product requirements in Section 34 21 17, TES Substation Design and Assembly
- B. Mounting: Suitable for pipe-mounting on OCS pole.

2.5 PADLOCKS

- A. Key as directed by Engineer.
- B. All locks keyed alike for each application, unless directed otherwise by the Engineer.
- C. Indoor:
 - 1. Heavy duty, rekeyable padlock, with minimum 3/8-inch diameter boron-alloy shackle with 2-inch clearance.
- D. Outdoor:
 - 1. Same as interior but outdoor-type with weather cover.
 - 2. Acceptable Manufacturer/ Product: Master Lock, Master Pro Series 6121KALJ.

2.6 FACTORY ASSEMBLY

- A. Torquing:
 - 1. Torque bolted connections in accordance with manufacturer's recommendations.
 - 2. Use a torque wrench calibrated within the past 12 months and bearing a calibration sticker.

3. Torque busses and bus connections per manufacturer's recommendations or according to the following table.

SILICON BRONZE BOLT STANDARD DRY TORQUE		
Bolt Size Inches	Threads/ inch	Inch Pounds
1/4	20	68.8
	28	87
5/16	18	123
	24	131
3/8	16	219
	24	240
7/16	14	349
	20	371
1/2	13	480
	20	502
9/16	12	632
	18	697
5/8	11	1030
	18	1154
3/4	10	1416
	16	1382

4. Torque cable connections per manufacturer's recommendations, or according to the following table.

STEEL BOLT STANDARD DRY TORQUE IN FOOT POUNDS							
		SAE Grade					
Bolt Size Inches	Course Threads/ inch	0-1-2	3	5	6	7	8
1/4	20	6	9	10	12.5	13	14
5/16	18	12	17	19	24	25	29
3/8	16	20	30	33	43	44	47
7/16	14	32	47	54	69	71	78
1/2	13	47	69	78	106	110	119
9/16	12	69	103	114	150	154	169
5/8	11	96	145	154	209	215	230
3/4	10	155	234	257	350	360	380

5. Apply torque mark after torquing connection.

PART 3 - EXECUTION**3.1 FIELD INSTALLATION**

- A. Requirements of Article titled "Factory Assembly" apply to field installation.
- B. Seal equipment enclosures against dust, whenever dusty conditions are present inside the rooms or outside, during the construction period.
- C. Provide seismic anchorage and bracing in accordance with submitted design and calculations.

3.2 INSTALLATION OF TES SUBSTATION AT PROJECT SITE

- A. Comply with requirements of Kansas City, including but not limited to the following:
 - 1. Obtain any required permits.
 - 2. Comply with installation requirements at the site.
 - 3. Obtain required inspections and approval.
- B. Before setting substation in place, provide a sealing strip between substation base and concrete slab.
- C. Anchor substation to slab using Contractor-furnished design sealed by a structural engineer registered in the State of Missouri.

3.3 TEMPORARY POWER AND HEAT

- A. Provide temporary heat within 24 hours of setting substation to prevent condensation inside the substation until permanent power is connected.
- B. Provide sufficient heat to maintain substation at 65 degrees, day and night.
- C. Provide temporary power to heater.
- D. A portable generator may be used as an alternate to temporary utility power.

3.4 INSTALLATION OF EXTERIOR BLUE LIGHT ON OCS POLE

- A. Provide blue light on remote OCS pole at locations indicated on Contract Drawings.
- B. Connect blue light to associated TES substation, as indicated on Contract Drawings, such that it illuminates for alarms indicated in Section 34 21 31, TES Substation Automation System (SAS).

PART 4 - MEASUREMENT AND PAYMENT**4.1 MEASUREMENT**

- A. The quantities of accepted work will be measured in the following units. All measurements will be plan measure except for authorized changes.
 - 1. Description: Lump Sum

4.2 PAYMENT

- A. Payment will be made at the respective unit or lump-sum price listed in the proposal and shall be full compensation for all labor, materials, and equipment necessary to complete the respective unit in place. There will be no separate measurement or payment for any item of work not specifically identified and listed in the proposal, and all such work shall be considered a subsidiary item with all costs pertaining thereto included in the prices for other items listed in the proposal. At the Engineer's option, partial payment may be made for any lump sum item listed in the proposal, providing that the Contractor is diligently and satisfactorily pursuing full completion of such partially complete item in accordance with the approved job progress schedule.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 34 21 06**COMMON WORK RESULTS FOR METALS****PART 1 - GENERAL****1.1 SUMMARY**

- A. This Section includes the following:
 - 1. Galvanizing.
 - 2. Welding.
 - 3. Shop-applied powder coat.
 - 4. Shop-applied paint coating system.

1.2 DEFINITIONS

- A. Hot-dip galvanizing: Dipping steel members and assemblies into molten zinc for lasting, or long-term corrosion protection. Resultant zinc coating fuses permanently with base steel material.
- B. Galvanneal: Zinc-iron alloy coating created on sheet steel by a continuous hot-dipping process followed by heat treatment in an annealing furnace.

1.3 RELATED SECTIONS

- A. SECTION 01 33 00 – Submittal Procedures

1.4 REFERENCED STANDARDS

- A. Section incorporates by reference the latest revisions of the following documents:
- B. The American Society for Nondestructive Testing (ASNT)
 - 1. ASNT CP-105, Standard Topical Outlines for Qualification of Nondestructive Testing Personnel
 - 2. Recommended Practice No. SNT-TC-1A: Personnel Qualification and Certification in Nondestructive Testing
- C. American Welding Society (AWS)
 - 1. AWS A5 Series, Filler Metal Specifications
 - 2. AWS B1.10M/B1.10, Guide for the Nondestructive Examination of Welds
 - 3. AWS D1.1/D1.1M, Structural Welding Code - Steel
 - 4. AWS D1.3/D1.3M, Structural Welding Code - Sheet Steel
 - 5. AWS QC1, Standard for AWS Certification of Welding Inspectors
 - 6. AWS QC7, Standard for AWS Certified Welders

- D. ASTM International (ASTM):
1. ASTM A53/A53M, Pipe, Steel, Black and Hot-Dipped Zinc-Coated, Welded and Seamless
 2. ASTM A123/A123M, Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
 3. ASTM A143/143M, Safeguarding against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement
 4. ASTM A153/A153M, Zinc Coating (Hot-Dip) on Iron and Steel Hardware
 5. ASTM A384/A384M, Safeguarding against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies
 6. ASTM A385/A385M, Providing High-Quality Zinc Coatings (Hot Dip)
 7. ASTM A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
 8. ASTM A780/A780M, Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
 9. ASTM B6, Standard Specification for Zinc
 10. ASTM B117, Standard Practice for Operating Salt Spray (Fog) Apparatus
 11. ASTM D522, Standard Test Methods for Mandrel Bend Test of Attached Organic Coatings
 12. ASTM D523, Standard Test Method for Specular Gloss
 13. ASTM D610, Standard Practice for Evaluating Degree of Rusting on Painted Steel Surfaces
 14. ASTM D714, Standard Test Method for Evaluating Degree of Blistering of Paints
 15. ASTM D968, Standard Test Methods for Abrasion Resistance of Organic Coatings by Falling Abrasive
 16. ASTM D1308, Standard Test Method for Effect of Household Chemicals on Clear and Pigmented Organic Finishes
 17. ASTM D2247, Standard Practice for Testing Water Resistance of Coatings in 100% Relative Humidity
 18. ASTM D2248, Standard Practice for Detergent Resistance of Organic Finishes
 19. ASTM D2485, Standard Test Methods for Evaluating Coatings For High Temperature Service
 20. ASTM D2794, Standard Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact)
 21. ASTM D3170, Standard Test Method for Chipping Resistance of Coatings
 22. ASTM D3359, Standard Test Methods for Measuring Adhesion by Tape Test
 23. ASTM D3363, Standard Test Method for Film Hardness by Pencil Test

24. ASTM D3451, Standard Guide for Testing Coating Powders and Powder Coatings
 25. ASTM D4060, Standard Test Method for Abrasion Resistance of Organic Coatings by the Taber Abraser
 26. ASTM D4541, Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers
 27. ASTM D4585, Standard Practice for Testing Water Resistance of Coatings Using Controlled Condensation
 28. ASTM D4798, Standard Practice for Accelerated Weathering Test Conditions and Procedures for Bituminous Materials (Xenon-Arc Method)
 29. ASTM D5894, ASTM D6132, Standard Test Method for Nondestructive Measurement of Dry Film Thickness of Applied Organic Coatings Using an Ultrasonic Gage
 30. ASTM D6132, Standard Test Method for Nondestructive Measurement of Dry Film Thickness of Applied Organic Coatings Using an Ultrasonic Gage
 31. ASTM D6695, Standard Practice for Xenon-Arc Exposures of Paint and Related Coatings
 32. ASTM D7091, Standard Practice for Nondestructive Measurement of Dry Film Thickness of Nonmagnetic Coatings Applied to Ferrous Metals and Nonmagnetic, Nonconductive Coatings Applied to Non-Ferrous Metals
 33. ASTM D7803, Standard Practice for Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Powder Coating
 34. ASTM E94, Guide for Radiographic Testing
 35. ASTM E164, Practice for Ultrasonic Contact Examination of Weldments
 36. ASTM E165, Standard Test Method for Liquid Penetrant Examination
 37. ASTM E709, Guide for Magnetic Particle Examination
 38. ASTM E1032, Method for Radiographic Examination of Weldments
 39. ASTM G151, Standard Practice for Exposing Nonmetallic Materials in Accelerated Test Devices that Use Laboratory Light Sources
 40. ASTM G155, Standard Practice for Operating Xenon Arc Light Apparatus for Exposure of Non-Metallic Materials
- E. The Society for Protective Coatings (SSPC)
1. SSPC-PA 1, Shop, Field, and Maintenance Painting of Steel
 2. SSPC-PA 2, Procedure for Determining Conformance to Dry Coating Thickness Requirements
 3. SSPC-PS 13.01, Epoxy Polyamide Painting System
 4. SSPC-SP6, Commercial Blast Cleaning
 5. SSPC-SP8, Pickling

1.5 SUBMITTALS

- A. Procedures: SECTION 01 33 00 – Submittal Procedures.
- B. Galvanizing:
 - 1. Certification:
 - a. Notarized certificates of compliance with ASTM requirements specified in this Section.
 - b. Certification that galvanizing is in conformance with this Section, signed by the galvanizer; include a detailed description of all material and methods used.
 - c. Certification of membership in American Galvanizers Association, signed by the galvanizer.
 - 2. Product Data:
 - a. Materials used for shop applied galvanizing.
 - b. Materials for field repair of shop applied galvanizing demonstrating conformance with specified standard. Include manufacturer's written directions for storage, handling, and application.
 - 3. Testing:
 - a. Source Quality Control inspection and test reports
 - b. Field Quality Control inspection and test reports
- C. Welding:
 - 1. Certification: Furnish notarized certificates of compliance with ASTM requirements specified in this Section.
 - 2. Welder Qualifications:
 - a. Submit record of AWS qualification for each welder to be employed in the Work.
 - b. Submit certified copies of qualification test records for each welder, welding operator and tack welder to be employed in the Work.
 - c. Submit welders' identification marks (I.D.) for each welder along with qualifications.
 - 3. Welding Procedures:
 - a. Before welding, submit the procedure that will be used for qualifying welding procedures.
 - b. For procedures other than those prequalified in accordance with AWS D1.1/D1.1M, submit a copy of procedure qualification test records in accordance with the qualification requirements of AWS D1.1/D1.1M.
 - 4. Welding Records and Data:
 - a. Submit records of ultrasonic testing to the Engineer upon completion.

-
- b. If field welding is permitted, submit descriptive data for field welding equipment.
- D. Shop-Applied Powder Coat:
- 1. Certification:
 - a. Certification that galvanizer is a member of Powder Coating Institute (PCI).
 - b. Certification that the finish is in conformance with this Section, signed by the applier.
 - c. Certification that the applicator has been authorized to provide the coating formulator's warranty.
 - 2. Product Data:
 - a. Descriptive and technical data sheets describing products proposed for use.
 - b. Documentation of application process.
 - 3. Qualifications Submittals (for each applicator) minimum 60 days before work is scheduled:
 - a. Evidence that powder coat applicator is PCI 3000 or PCI 4000 Certified.
 - b. Evidence that the applicator is an approved and authorized applicator of the coating formulator's products.
 - c. Evidence that the applicator is experienced in applying powder coat successfully to the specified substrate (e.g. galvaneal with minimum coating weight A25).
 - d. Applicator's quality control procedures.
 - 4. Powder Coat Samples: Submit for each color and substrate one 12-inch square of heavy gage sheet metal with the primer, top coat, and graffiti coat applied. Stagger each coat such that the Engineer's can view each.
 - 5. Testing: Certified test results evidencing compliance of applied coatings with the application and testing requirements specified in this Section.
 - 6. Repair:
 - a. Manufacturer recommended repair procedures and materials procedures for field touchup of marred or damaged coatings using air-drying spray materials in matching colors.
 - b. If repair is necessary, submit repair sample after salt spray testing.
 - 7. Maintenance Information: Manufacturer's recommended maintenance materials and procedures.
- E. Shop-Applied Paint Coating System:
- 1. Certifications.
 - a. Certification that the finish is in conformance with this Section, signed by the applier.

- b. Certification that the applicator has been authorized to provide the coating formulator's warranty.
2. Product Data:
 - a. Performance characteristics: For each substrate used, the tested performance characteristics of the coating.
 - b. Documentation of application process.
3. Paint Coating System Samples: Submit for each color and substrate one 12-inch square of heavy gage sheet metal with the primer, top coat, and graffiti coat applied. Stagger each coat such that the Engineer's can view each.

1.6 QUALITY ASSURANCE

- A. Comply with the requirements of the Project Quality Plan.
- B. Single Source for Galvanized and Finished Metal Fabrications:
 1. Use products of one manufacturer on each specific item to ensure exact color match and finish appearance.
- C. Galvanizing:
 1. Galvanizing firm shall be member of American Galvanizers Association Inc. (AGA).
 2. Inspection and Tests:
 - a. Inspections, test and samples shall conform with ASTM Specifications and Standards.
 - b. Inspection rights and privileges, procedures and acceptance or rejection of galvanized steel materials shall conform with ASTM A123/A123M.
- D. Welding:
 1. Welder Qualifications:
 - a. Welding shall be done by qualified, certified welders who make only those welds for which they have been qualified in accordance with AWS, or other approved qualifying procedures.
 - b. Welders, Welding operators, and tack welders shall be certified in accordance with AWS D1.1/D1.1M.
 - c. For sheet steel, welders shall be qualified in accordance with AWS QC7 and AWS D1.3/D1.3M, Qualification Section.
 - d. Records of welder qualification tests shall be made available for review upon the Engineer's request.
 2. Welding Procedure Qualification:
 - a. Welding procedures shall be prequalified or qualified in accordance with AWS D1.1/D1.1M.
 - b. For sheet steel, proposed welding procedures shall be qualified in accordance with AWS D1.3/D1.3M. Prequalification is not applicable to sheet steel.

3. Welding Inspector Qualifications:
 - a. Welds to be inspected by the Contractor shall be inspected and certified by an AWS Certified Welding Inspector (CWI).
 - b. CWI shall be certified in accordance with AWS QC1.
 4. Nondestructive Testing Personnel Qualifications:
 - a. Qualified and certified in accordance with SNT-TC-1A and ASNT CP-105.
 - b. Certified for NDT Level I and working under a person or persons certified for NDT Level II or Level III.
 5. Welding Records:
 - a. Retain mill certificates and certified copy of reports for analyses and tests required by referenced ASTM and AWS specifications.
 - b. Retain radiographs upon completion of fabrication.
 - c. Retain certifications that magnetic particle and dye-penetrant inspections have been satisfactorily completed.
- E. Shop-Applied Powder Coating:
1. Powder coating firm shall be member of the Powder Coating Institute (PCI).
 2. Applicator Qualifications:
 - a. Engage an experienced coating applicator that is PCI 3000 or PCI 4000 certified.
 - b. Applicator shall have demonstrated the ability to properly apply the coating to the specified substrate and have quality control procedures firmly established in its shop.
 - c. Engineer may, at his option, visit the applicator's facility to confirm adherence to quality control procedures.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, handle, and store metal fabrications in a manner that prevents damage to the item, its galvanizing, and its finish.

1.8 WARRANTY

- A. Scope: Warranty applies to the following:
 1. Coating applied to shop welds.
 2. Shop-applied powder coat.
 3. Shop-applied paint coating system.
- B. Warranty Period: 5 years.

- C. Furnish written warranty starting on date of conditional acceptance stating that shop-applied coating will not blister, peel, crack, chalk, change color or have other forms of degradation during warranty period.
- D. Coating failure:
 - 1. In the event that coating failure occurs within warranty period, replace item indicating coating failure, including full cost of labor and materials for such replacement.
 - 2. Replacement items shall be new and finished with same type coating meeting requirements of this Section.
 - 3. Replacement items shall match adjacent members.
- E. The Engineer may permit field repairs in lieu of replacement, provided coating failure is minor in scope and field repair material and method employed match its adjacent member. Repairs shall be compatible with original surface.

PART 2 - PRODUCTS

2.1 SHOP-APPLIED GALVANIZING

- A. General:
 - 1. Wherever materials are called out as "hot-dip galvanized" or "galvanized," provide a zinc coating after fabrication in accordance with ASTM A123/A123M.
 - 2. Hardware items such as bolts or other threaded fasteners shall be hot-dip galvanized after fabrication in accordance with A153/A153M.
 - 3. Specified materials or products that are not readily available in the specified hot-dip finish, shall be custom hot dipped after manufacture by an independent galvanizer.
- B. Selection, Design, and Fabrication Before Galvanizing:
 - 1. Verify with supplier or fabricator that material is chemically suitable for galvanizing.
 - 2. Warpage: Design assemblies as recommended in ASTM A384/A384M to limit warpage and distortion during hot-dip galvanizing.
 - a. Notify the Engineer of potential warpage problems that require modification in design before proceeding with steel fabrications.
 - b. Costs for alternative designs shall be performed at no additional cost to Owner.
 - 3. Design and fabricate assemblies requiring shop fabrication using methods recommended in ASTM A385/A385M to obtain high quality hot-dip galvanized coating.
 - 4. Embrittlement: Select proper steel, design assemblies, and thermally treat before galvanizing as recommended in ASTM A143/A143M to withstand normal galvanizing operations without embrittlement.
 - 5. Galvanizer Coordination Drawings: Furnish shop drawings to galvanizer of non-standard fabrications, tubular fabrications, and fabrications with materials of different thicknesses.

6. Inspect iron and steel hardware before galvanizing and verify suitability for galvanizing. Replace items that are not suitable for galvanizing.
 7. When the item to be galvanized incorporates threaded assemblies, make provisions in thread size to accommodate galvanizing and galvanize disassembled.
 8. Weld, drill, and assemble galvanized members before galvanizing.
- C. Hot-Dip Galvanizing Material:
1. Galvanizing bath shall contain 0.05 to 0.09 percent nickel by weight.
 2. Zinc for galvanizing: Conform to ASTM B6, as specified in ASTM A123/A123M.
- D. Preparation:
1. Remove all welding slag, splatter, and burrs.
 2. Clean all surfaces in conformance with SSPC SP6, Commercial Blast Cleaning.
 3. Pickle all surfaces in conformance with SSPC SP8, Pickling.
 4. Safeguard against increasing the likelihood of steel embrittlement during pickling in accordance with ASTM A143/A143M.
 5. Mask galvanized members that are to be field or shop welded after galvanizing to a distance of 1 inch from weld line before galvanizing.
- E. Hot-Dip Galvanizing:
1. Select a galvanizer with galvanizing kettle large enough to accommodate the largest member or assembly requiring hot-dip galvanizing. Progressive dipping shall not be used.
 2. Hot-dip galvanize structural steel and metal fabrications as indicated in conformance with ASTM A123/A123M.
 3. Hot-dip galvanize bolts or other threaded fasteners after fabrication in accordance with A153/A153M.
 4. Thickness of zinc coating: Conform to requirements of ASTM A123/A123M or ASTM A153/A153M, whichever is applicable.
 5. Finish, uniformity, and adherence of coating: Conform to requirements of ASTM A123/A123M or ASTM A153/A153M, whichever is applicable.
 6. Galvanized members on which powder coat or paint will be applied shall not be quenched by the galvanizer.
 7. Galvanizer's Stamp: Galvanized materials shall be marked with the galvanizer's stamp.
- F. Mechanical Galvanizing shall not be used.

2.2 WELDING

- A. Weldability of Steel: For structural steel requiring impact test qualification and for corrosion resistant structural steel, establish weldability of steel and procedures for welding it by qualification in accordance with AWS D1.1/D1.1M, to match the notch toughness and weathering characteristics of the base metal.
- B. Rod/Electrodes:
1. Electrodes for structural plate, shapes, pipe, tubes, and bars shall conform to AWS A5 Series Standards and shall be coated rods or wire of size and classification number as recommended by their manufacturers for the conditions of actual use.
 2. Electrodes for sheet steel shall conform to AWS A5 Series Standards and shall be coated rods or wire of size and classification number, as recommended by their manufacturers for the conditions of actual use.
 3. Matching filler metal requirements shall conform to AWS D1.1/D1.1M, Table 3.1.
- C. Stud Shear Connectors: Only products of manufacturers qualified in accordance with AWS D1.1/D1.1M will be accepted for this Work.
- D. Shop Welding:
1. Perform shop welding as indicated in accordance with AWS D1.1/D1.1M, and AWS D1.3/D1.3M, as applicable to the Work.
 2. Welders shall mark adjacent to completed welds their welder I.D., using metal stamp, metal engraving, keel, paint stick, or other appropriate marking material.
 3. Welding of stud shear connectors shall conform to AWS D1.1/D1.1M, Section 7. "Stud Welding," and the stud manufacturer's instructions.
- E. Coating Shop Welds:
1. Coat shop welds made after hot-dip galvanizing and areas masked to permit welding as follows:
 - a. Provide an inorganic ethyl silicate primer containing 85 percent zinc by weight in the dry film.
 - b. Prepare surface in strict compliance with manufacturer's recommended procedures.
 - c. Apply a single coat of 75 microns dry film thickness in strict accordance with manufacturer's application instructions.
 - d. Top coat is required only if surrounding surface is painted, or if necessary to match color of surrounding area.
 - e. Where top coating is required, provide a compatible product and apply according to manufacturer's instructions to achieve good cohesion and prevent pinholing.
 2. Color: Match color of surrounding area.

2.3 SHOP-APPLIED POWDER COAT

- A. Provide shop-applied polyester triglycidyl isocyanurate (T.G.I.C.) coatings, thermo-cured color finish systems based on dry, powdered resins, commonly known as "powder coat."
- B. Powder coat system shall meet the requirements listed below in the Article titled "Source Quality Control" in the Paragraph titled "Shop-Applied Powder Coating Testing," when applied on the specified substrate, e.g. hot dip galvanized steel or galvanized sheet steel.
- C. Preparation before coating:
 - 1. Hot-dip galvanized per ASTM A123/A123M: Prepare surface in accordance with ASTM D7803.
 - 2. Galvanized per ASTM A653/A653M: Prepare surface in accordance with ASTM D7803
 - 3. Cleaning:
 - a. Clean surfaces to be coated as follows:
 - 1) Remove all dust, dirt, and other surface debris by vacuuming, wiping dry with clean cloths or compressed air.
 - 2) Rinse scrubbed surfaces with clean water until foreign matter is flushed from surface.
 - 3) Allow surfaces to drain completely and allow to thoroughly dry.
 - 4) Use water blasting only when necessary for extreme cases of contamination by oily residue and where hand washing is impractical.
 - 5) If the above procedures do not clean the substrate surfaces, clean the surfaces with high pressure water washing.
 - 4. Pretreatment:
 - a. Wash parts in a four stage iron-phosphate washer for steel or zinc-phosphate washer for galvanized steel, or in accordance with primer manufacturer's recommendations.
 - b. Dry parts before application of powder coating.
 - c. Treatment of the substrate: ASTM D3451.
- D. Powder Coat:
 - 1. Primer: Apply primer compatible with powder top coat, as confirmed by powder coat manufacturer.
 - 2. Top Coat: Acceptable Manufacturer/Product: Tiger Drylac, or approved equal.
 - 3. Anti-Graffiti Coating:
 - a. Apply as final coat on exterior surfaces.

- b. Powder coating intended for easy removal of typical spray paint used for graffiti.
 - c. Compatible with top coat.
- E. Dry Film Thickness:
 - 1. Primer: 3.5 mils minimum.
 - 2. Top coat: 3.5 mils minimum.
 - 3. Anti-graffiti coating: As recommended by manufacturer.
- F. Perform mechanical processing such as sawing, drilling, milling, cutting, and bending before applying shop applied coatings.
- G. Coating shall meet the testing requirements of ASTM D3451 and other standards indicated below:
 - 1. Physical Properties of Powder Coatings:
 - a. Measurement of film thickness: ASTM D6132 or ASTM D7091.
 - b. Abrasion resistance: ASTM D968.
 - c. Adhesion: ASTM D3359, Method B, 5B.
 - d. Elongation (flexibility): Mandrell Bending Test, ASTM D522, equal to or greater than 3 mm.
 - e. Household chemical resistance: ASTM D1308.
 - f. Detergent resistance: ASTM D2248.
 - g. Chip resistance: ASTM D3170.
 - h. Gloss:
 - 1) Interior: 25 to 40 percent reflective gloss.
 - 2) Exterior: ASTM D523, 80 to 90 plus.
 - i. Pencil hardness:
 - 1) Interior: ASTM D3363, F minimum.
 - 2) Exterior: ASTM D3363, 4H (minimum).
 - j. Impact resistance: ASTM D2794, 80 (in/lb), no appearance of cracks.
 - 2. Accelerated Artificial Weathering: ASTM D6695, ASTM G151, ASTM G155.
 - 3. Accelerated Environmental Exposure:
 - a. Salt spray:
 - 1) Interior: ASTM B117, maximum undercut failure of 1/16 inch at scribed test lines; no blistering.

-
- 2) Exterior: ASTM B117, 500 hours, maximum undercut failure 1 (mm); no blistering.
 - b. Humidity Resistance: ASTM D2247, 500 hours, maximum undercutting 1 mm, no blistering.
- H. Perform mechanical processing such as sawing, drilling, milling, cutting, and bending before applying shop applied coatings.
- I. Cleaning:
1. Clean surfaces to be coated as follows:
 - a. Remove all dust, dirt, and other surface debris by vacuuming, wiping dry with clean cloths or compressed air.
 - b. Rinse scrubbed surfaces with clean water until foreign matter is flushed from surface.
 - c. Allow surfaces to drain completely and allow to thoroughly dry.
 - d. Use water blasting only when necessary for extreme cases of contamination by oily residue and where hand washing is impractical.
 - e. If the above procedures do not clean the substrate surfaces, clean the surfaces with high pressure water washing.
- J. Pretreatment:
1. Wash parts in a four stage iron-phosphate washer for steel or zinc-phosphate washer for galvanized steel, or in accordance with primer manufacturer's recommendations.
 2. Dry parts before application of power coating.
 3. Treatment of the substrate: ASTM D3451.
- K. Application:
1. Edges: Treat and finish as required to ensure specified minimum dry film coating thickness is achieved. Precoating of edges may be required.
 2. Apply primer in accordance with manufacturer's written application instructions.
 3. Apply top coat in accordance with manufacturer's written application instructions.
 4. Allow surfaces to cure for time period in accordance with manufacturer's cure curves.
 5. Inspect parts after cooling.
- L. Color:
1. TES Substation Enclosure Exterior: Color will be provided by the Engineer.
 2. TES Substation Enclosure Interior: RAL 9010, Pure White.
 3. Electrical Equipment: Munsell Color System 8.3G 6.1/0.5 (ANSI 61 grey).

2.4 SHOP-APPLIED PAINT COATING SYSTEM

- A. General Requirements:
1. Coatings must be certified VOC compliant and conform to applicable regulations and EPA standards.
 2. Material Compatibility:
 - a. Provide primers, finish coat materials and related materials that are compatible with one another and the steel substrate.
 - b. Furnish documentation from manufacturer demonstrating compatibility in both application and service based on testing and field experience.
 3. Material Quality:
 - a. Provide highest grade of coatings as regularly manufactured by acceptable coating manufacturers.
 - b. Materials not displaying manufacturer's identification as a best-grade product will not be acceptable.
 4. Coating system shall meet the requirements listed below in the Article titled "Source Quality Control" in the Paragraph titled "Shop-Applied Paint Coating System Testing," when applied on the specified substrate, e.g. hot dip galvanized steel or galvanized sheet steel.
- B. Primer: Polyamide epoxy, 4-6 mils DFT.
- C. Top Coat:
1. High solids, pigmented, aliphatic polyurethane, minimum 4 mils DFT.
 2. Color: As specified, as indicated, or as directed by the Engineer.
- D. Anti-Graffiti Coat:
1. Clear, aliphatic polyurethane non-sacrificial coating designed to resist graffiti and protect the underlying substrate.
 2. From the same manufacturer and compatible with approved top coat.
- E. Acceptable Manufacturers/Brands:
1. AkzoNobel/ICI Paints/Devco High Performance Coatings;
 2. Carboline;
 3. PPG Protective and Marine Coatings ;
 4. Tnemec; or approved equal.
- F. Shop-Applied Paint Coating Application:
1. Prepare steel in accordance with paint manufacturer's recommendations.
 - a. Verify with paint manufacturer that proposed surface cleaner is compatible with approved paint coating system.

- b. Apply paint as soon as possible after surface preparation.
2. Primer:
 - a. Shop-apply in accordance with SSPC-PA 1, SSPC-PA 2, SSPC-PS 13.01, and manufacturer's instructions.
 - b. Verify DFT in accordance with SSPC-PA 2.
3. Top coat: Shop-apply in accordance with manufacturer's instructions.
4. Graffiti coat: Shop apply two coats in accordance with manufacturer's instructions.

2.5 SOURCE QUALITY CONTROL

- A. Shop Inspections and Tests by the Engineer:
 1. Galvanizing, shop applied coatings, and welds are subject to inspections and tests by the Engineer.
 2. The Engineer will make test results available to the Contractor.
- B. Galvanizing:
 1. Shop Galvanizing Inspection and Test:
 - a. Inspect and test galvanizing for full coverage and adhesion to steel in accordance with ASTM A123/A123M or ASTM A153/A153M, whichever is applicable.
 - b. Inspection and test shall include the following:
 - 1) Visual examination of samples and finished products.
 - 2) Tests to determine weight or mass of zinc coating per square foot of steel surface.
 - 3) Tests to determine distribution and uniformity of zinc coating.
 - 4) Tests to determine thread fittings of units, washers to bolts.
 - c. Test hardware or assemblies susceptible to embrittlement in accordance with ASTM A143/A143M. The Engineer will make the final determination on whether embrittlement testing is required.
 - d. Shop Galvanizing Repair:
 - 1) Grind rough areas to produce a uniform surface.
 - 2) Repair steel grinding, scratches and other damage, in accordance with ASTM A780/A780M.
 - 3) Sprayed Zinc: Clean and preheat to assure freedom from loose material, moisture, oil grease, or other foreign matter before applying zinc. Apply zinc coating by metallizing spray to clean and dry surfaces.

-
- 4) Zinc-Based Solders and Wire:
 - a) Clean to remove loose material and contaminates, and heat to approximately 572 degrees F.
 - b) Apply zinc-alloy repair compound by spreading material over heated surface in accordance with compound manufacturer's instructions.
 - c) Remove repair compound residues with damp cloth or by rinsing with water.
 - 5) Organic cold galvanizing coating:
 - a) Minimum 95 percent metallic zinc by weight in dried film.
 - b) Approved Manufacturer: ZRC Products Company, or approved equal.
2. Dry film thickness of applied repair materials: Not less than galvanized coating thickness required by ASTM A53/A53M, A123/A123M, or A153/A153M.
- C. Welding Inspections and Tests by the Contractor:
1. Visual Inspection:
 - a. All welds shall be visually examined in accordance with AWS D1.1/D1.1M.
 - b. Quality of welds and standards of acceptance shall be in accordance with AWS D1.1/D1.1M.
 2. Inspection and Testing Type Requirements:
 - a. Nondestructive Testing: Conform to AWS B1.10M/B1.10.
 - b. Liquid Penetrant Inspection: Liquid dye penetrant inspection of welds shall conform to ASTM E165.
 - c. Magnetic Particle Inspection: Magnetic particle inspection of welds shall conform to ASTM E709.
 - d. Ultrasonic Testing: Comply with AWS D1.1/D1.1M and ASTM E164, as applicable.
 - e. Radiographic Testing: Comply with AWS D1.1/D1.1M and ASTM E94 and ASTM E1032, as applicable.
 3. Inspect complete and partial joint penetration groove welds and fillet welds using magnetic particle inspection as follows:
 - a. One out of five (20 percent) of complete joint penetration groove welds of tee and corner joints.
 - b. One out of ten (ten percent) of partial joint penetration groove welds and fillet welds.
 4. Random Testing: Randomly test 10 percent of welds by either liquid penetrant inspection or magnetic particle inspection.

5. Additional Testing: If random testing reveals possible flaws, test the welds in question, and additional welds if directed by the Engineer, using ultrasonic or radiographic testing. Requirement for this additional testing shall be at no additional cost to the Owner and shall be at the sole discretion of the Engineer.
 6. Test complete joint penetration groove welds by radiographic testing as follows:
 - a. One out of ten (ten percent) with thickness equal to or less than 3/4 inch.
 - b. One out of two (50 percent) with thickness greater than 3/4 inch and equal to or less than 1.5 inches.
 - c. 100 percent for thickness greater than 1.5 inches.
 - d. Complete joint penetration groove welds not accessible for radiographic testing shall be subjected to ultrasonic testing. The extent shall be the same as specified for radiographic testing.
 7. Inspection and Test Results:
 - a. Forward test result information to the Engineer immediately after test results are available.
 - b. State the acceptance or rejection of fabricated components, so that repairs and reinspection or testing may be performed as soon as possible.
 8. Repairs:
 - a. Repair unacceptable welds in accordance with AWS D1.1/D1.1M.
 - b. Reinspect or retest repaired or corrected welds as specified for the original weld.
- D. Shop-Applied Powder Coating Testing:
1. Coating shall meet or exceed the following testing requirements and performance criteria of ASTM D3451 and other standards indicated below.
 2. Physical Properties of Powder Coatings:
 - a. Measurement of film thickness: ASTM D6132 or D7091.
 - b. Abrasion resistance: ASTM D968.
 - c. Adhesion: ASTM D3359, Method B, 5B.
 - d. Elongation (flexibility): Mandrell Bending Test, ASTM D522, equal to or greater than 3 mm.
 - e. Household chemical resistance: ASTM D1308.
 - f. Detergent resistance: ASTM D2248.
 - g. Chip resistance: ASTM D3170.
 - h. Gloss:
 - 1) Interior: 25 to 40 percent reflective gloss.
 - 2) Exterior: ASTM D523, 80 to 90 plus.

- i. Pencil hardness:
 - 1) Interior: ASTM D3363, F minimum.
 - 2) Exterior: ASTM D3363, 4H (minimum).
 - j. Impact resistance: ASTM D2794, 80 (in/lb), no appearance of cracks.
 - 3. Accelerated Artificial Weathering: ASTM D6695, ASTM G151, ASTM G155.
 - 4. Accelerated Environmental Exposure:
 - a. Salt spray:
 - 1) Interior: ASTM B117, maximum undercut failure of 1/16 inch at scribed test lines; no blistering.
 - 2) Exterior: ASTM B117, 500 hours, maximum undercut failure 1 (mm); no blistering.
 - b. Humidity Resistance: ASTM D2247, 500 hours, maximum undercutting 1 mm, no blistering.
- E. Shop-Applied Paint Coating System Testing:
- 1. Primer shall meet or exceed the following testing requirements and performance criteria of the standards indicated below:
 - a. Abrasion Resistance per ASTM D4060 (CS17 Wheel, 1,000 grams load), 1 kg Load: 200 mg loss.
 - b. Adhesion per ASTM D4541: 1050 psi.
 - c. Corrosion Weathering per ASTM D5894, 13 Cycles, 4,368 Hours: Rating 10 per ASTM D714 for blistering; Rating 7 per ASTM D610 for rusting.
 - d. Direct Impact Resistance per ASTM D2794: 160 inch pounds.
 - e. Flexibility per ASTM D522, 180 degree Bend, 1 inch Mandrel: Passes.
 - f. Pencil Hardness per ASTM D3363: 3B.
 - g. Moisture Condensation Resistance per ASTM D4585, 100 degrees F, 2000 Hours: Passes, no cracking or delamination.
 - h. Dry Heat Resistance per ASTM D2485: 250 degrees F.
 - 2. Top Coat shall meet or exceed the following testing requirements and performance criteria of the standards indicated below:
 - a. Abrasion Resistance per ASTM D4060, CS17 Wheel, 1,000 Cycles 1kg Load: 87.1 mg loss.
 - b. Adhesion per ASTM D4541: 1050 psi.
 - c. Direct Impact Resistance per ASTM D2794: Greater than 28 inch pounds.
 - d. Indirect Impact Resistance per ASTM D2794: 12-14 inch pounds.
 - e. Dry Heat Resistance per ASTM D2485: 200 degrees F.

- f. Salt Fog Resistance per ASTM B117 9,000 Hours: Rating 10 per ASTM D714 for blistering.
- g. Flexibility per ASTM D522, 180 Degree Bend, 1/8 Inch Mandrel: Passes.
- h. Pencil Hardness per ASTM D3363: 2H.
- i. Moisture Condensation Resistance per ASTM D4585, 100 degrees F, 1000 Hours: No blistering or delamination.
- j. Xenon Arc Test per ASTM D4798: Pass 300 hours.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Field Welding: Shall be performed as specified for shop welding.

3.2 SITE QUALITY CONTROL

- A. Galvanizing: After delivery of substation, inspect and repair damage to galvanizing.
 - 1. Repair field cutting of metal, welds, steel grinding, scratches and other damages, and coat masked areas, in accordance with ASTM A780/A780M.
 - 2. Dry film thickness of applied repair materials: Not less than galvanized coating thickness required by ASTM A53/A53M, A123/A123M, or A153/A153M.
- B. Shop Applied Coating: After delivery of substation, inspect and repair damage to shop applied coating.
 - 1. Repair minor film scratches and other blemishes in film surfaces in accordance with coating manufacturer's recommended procedures and materials.
 - a. Submit recommended procedures and materials.
 - b. Prepare a sample demonstrating the proposed repair procedures and materials, and subject to salt spray test per ASTM B117.
 - c. Submit the sample after testing.
 - 2. Finished repairs shall match original finish for color and gloss, shall adhere to original finish, and shall exhibit no removal of coating film or blistering during dry adhesion testing when tested in accordance with ASTM D3359.
 - 3. Remove coated items damaged beyond repair and replace with newly fabricated and coated items.
- C. Welding Inspections and Tests:
 - 1. Perform tests of field welds as specified for shop welds.
 - 2. Engineer will perform visual inspections of field welds as specified for shop welds.

PART 4 - MEASUREMENT AND PAYMENT**4.1 MEASUREMENT**

A. The quantities of accepted work will be measured in the following units. All measurements will be plan measure except for authorized changes.

1. Description: Lump Sum

4.2 PAYMENT

A. Payment will be made at the respective unit or lump-sum price listed in the proposal and shall be full compensation for all labor, materials, and equipment necessary to complete the respective unit in place. There will be no separate measurement or payment for any item of work not specifically identified and listed in the proposal, and all such work shall be considered a subsidiary item with all costs pertaining thereto included in the prices for other items listed in the proposal. At the Engineer's option, partial payment may be made for any lump sum item listed in the proposal, providing that the Contractor is diligently and satisfactorily pursuing full completion of such partially complete item in accordance with the approved job progress schedule.

END OF SECTION

SECTION 34 21 08**TES DIELECTRIC EPOXY FLOORING****PART 1 - GENERAL****1.1 SUMMARY**

- A. This Section includes trowel-applied, dielectric, epoxy-resin flooring for TES substation floors.

1.2 RELATED SECTIONS

- A. SECTION 01 33 00 – Submittal Procedures
- B. SECTION 34 21 90 – TES Testing

1.3 REFERENCED STANDARDS

- A. Section incorporates by reference the latest revisions of the following documents:
- B. ASTM International (ASTM)
 - 1. ASTM D149, Standard Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies
 - 2. ASTM D695, Standard Test Method for Compressive Properties of Rigid Plastics
 - 3. ASTM D4541, Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers
 - 4. ASTM F2170, Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes

1.4 SUBMITTALS

- A. Procedures: SECTION 01 33 00 – Submittal Procedures.
- B. Product Data:
 - 1. Epoxy flooring materials and performance characteristics.
 - 2. Preparation and installation instructions.
- C. Installer Certificates: Signed by manufacturers certifying that installers comply with requirements in Article titled "Quality Assurance."
- D. Operation and Maintenance Data:
 - 1. Submit manufacturer's cleaning and maintenance instructions.
 - 2. Submit immediately after approval of product data.

1.5 QUALITY ASSURANCE

- A. Comply with the requirements of the Project Quality Plan.
- B. Installer Qualifications:
 - 1. Engage an installer who is certified in writing by epoxy flooring manufacturer as qualified to install manufacturer's products.
 - 2. Workers performing installation must be skilled and experienced in the installation of the approved product.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to assembly site in supplier's original wrappings and containers, labeled with source's or manufacturer's name, material or product brand name, and lot number.
- B. Store materials in their original, undamaged packages and containers, inside a well-ventilated area protected from weather, moisture, soiling, extreme temperatures, and humidity.

PART 2 - PRODUCTS**2.1 PERFORMANCE REQUIREMENTS**

- A. Provide flooring capable of the following when applied at 1/4-inch thickness:
 - 1. Dielectric service, in accordance with ASTM D149: 58,000 Vdc.
 - 2. Bond strength to concrete in accordance with ASTM D4541: 400 psi minimum.
 - 3. Abrasion Resistance: Not more than 0.5 grams loss when tested with Tabor abrader with 1000 gram load for 1000 cycles.
 - 4. Compressive strength per ASTM D695: 8500 psi.
- B. Performance of In-Place Flooring: Capable of withstanding testing conditions specified in 34 21 90, TES Testing without arcing or passing current beyond specified limit.

2.2 EPOXY-RESIN FLOORING

- A. Epoxy-Resin Flooring: Subject to compliance with requirements, provide Hallemite Dielectric Grey Amazite by RBC Industries, Inc., or approved equal.
 - 1. Thickness: 1/4 inch nominal.
 - 2. Color: Manufacturer's standard grey.
- B. Materials:
 - 1. Epoxy-Resin Matrix: Manufacturer's standard recommended for use indicated.
 - 2. Aggregates: Silica sand in gradation recommended by resin manufacturer.

2.3 SHOP APPLICATION

- A. Application Conditions:
1. Environmental Limitations: Comply with manufacturer's written instructions for substrate temperature, ambient temperature, moisture, ventilation, and other conditions affecting flooring installation.
 2. Provide permanent lighting or, if permanent lighting is not in place, simulate permanent lighting conditions during flooring installation.
 3. Close spaces to traffic during flooring application and for not less than 24 hours after application unless manufacturer recommends a longer period.
- B. Preparation:
1. Clean substrates of substances, including oil, grease, and curing compounds, that might impair flooring bond. Provide clean, dry, and neutral substrate for flooring application.
 2. Rough sand metallic floors as recommended by manufacturer to insure adhesion.
 3. Apply masking at stop points and at adjacent surfaces that are not to be coated, so that the flooring will finish at clean lines.
- C. Epoxy-Resin Flooring Installation:
1. Apply the epoxy to the area shown on Contract Drawings.
 2. Place and finish flooring according to manufacturer's written instructions.
 3. Installation Tolerance: Limit variation in flooring surface from level to 1/4 inch in 10 feet; non-cumulative.
 4. Where the edge joins the bare floor, taper the material from the full thickness to the height of the floor over a minimum of a 6-inch wide area.
 5. Ensure that matrix components and fluids from grinding operations do not stain flooring by reacting with divider and control-joint strips.
 6. Primer: Apply to flooring substrates according to manufacturer's written instructions.
 7. Install epoxy floor coating to a minimum thickness of 1/4 inch as a one piece surface.
 8. Where the epoxy floor covering meets a wall insulating panel, the floor covering shall completely fill gap to a minimum thickness of 1/4 inch.

2.4 PROTECTION

- A. During equipment installation, provide protective covering to keep the epoxy floor clean and free from damage.

2.5 SOURCE QUALITY CONTROL

- A. Inspect floor for cracks and joints. Repair in accordance with manufacturer's recommendations.
- B. Cut out and replace flooring areas that evidence lack of bond with substrate.
- C. Cut out flooring areas in panels defined by strips and replace to match adjacent flooring, or repair panels according to manufacturer's written recommendations, as approved by the Engineer.
- D. Testing: Test in accordance with Section 34 21 90, TES Testing. If flooring fails to provide specified level of electrical insulation, apply additional layers of epoxy until specified levels are achieved.

PART 3 - EXECUTION**3.1 VMF FIELD APPLICATION**

- A. Coordinate schedule so that building systems are fully installed before installation of dielectric floor to prevent damage to floor.
- B. Building and premises shall be clean, warm, and dry before installation of dielectric epoxy floor.
- C. Prepare concrete floor as directed by manufacturer to insure adhesion.
- D. Verify that concrete substrate is dry and moisture-vapor emissions are within acceptable levels according to manufacturer's written instructions.
 - 1. Moisture Testing: Perform tests indicated below.
 - a. In-Situ Probe Test: Perform relative-humidity test using in-situ probes in accordance with ASTM F 2170.
 - b. Proceed with installation only after substrates have a maximum 75 percent relative-humidity-level measurement.
- E. Block drains to prevent the entrance of epoxy-resin.
- F. Requirements of Articles titled "Shop Application" and "Protection" apply to field fabrication.

3.2 FIELD QUALITY CONTROL

- A. Inspection: After delivery to site, inspect floor for shipping damage.
- B. Testing:
 - 1. Prefabricated Substations: After delivery to site, test in accordance with Section 34 21 90, TES Testing, to ensure that floor has not been damaged during shipping.
 - 2. Built-in-Place VMF Substation: After installation of floor and before installation of substation equipment, test in accordance with Section 34 21 90, TES Testing.

PART 4 - MEASUREMENT AND PAYMENT**4.1 MEASUREMENT**

A. The quantities of accepted work will be measured in the following units. All measurements will be plan measure except for authorized changes.

1. Description: Lump Sum

4.2 PAYMENT

A. Payment will be made at the respective unit or lump-sum price listed in the proposal and shall be full compensation for all labor, materials, and equipment necessary to complete the respective unit in place. There will be no separate measurement or payment for any item of work not specifically identified and listed in the proposal, and all such work shall be considered a subsidiary item with all costs pertaining thereto included in the prices for other items listed in the proposal. At the Engineer's option, partial payment may be made for any lump sum item listed in the proposal, providing that the Contractor is diligently and satisfactorily pursuing full completion of such partially complete item in accordance with the approved job progress schedule.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 34 21 10**TES SELF-CONTAINED EYEWASH EQUIPMENT****PART 1 - GENERAL****1.1 SUMMARY**

- A. This section includes self-contained eyewash equipment for installation in TES substations.

1.2 REFERENCED STANDARDS

- A. Section incorporates by reference the latest revisions of the following documents:
- B. American National Standards Institute (ANSI)
1. ANSI Z358.1, Standard for Emergency Eyewash and Shower Equipment

1.3 SUBMITTALS

- A. Procedures: Section 01 33 00, Submittal Procedures.
- B. Product Data:
1. Eyewash station.
 2. Eyewash solution cartridge.
- C. Operation and Maintenance Data:
1. Submit manufacturer's operating and maintenance instructions on products specified in this Section.
 2. Submit immediately after approval of product data

PART 2 - PRODUCTS**2.1 MATERIALS**

- A. Eyewash Stations:
1. Self-contained eyewash station meeting the requirements of ANSI Z358.1 using factory-sealed cartridges of eyewash solution.
 2. Eyewash stations shall be suitable for wall mounting at locations indicated on Contract Documents and incorporate a fluid reservoir for discharged solution.
- B. Eyewash Saline Assembly:
1. Factory-sealed cartridge assembly containing contaminant-free, pH-balanced saline solution with integral nozzle(s) for solution delivery in a gentle flow meeting ANSI Z358.1 requirements.
 2. Cartridge assemblies shall have a two-year shelf life from date of manufacture.

2.2 MANUFACTURER

- A. Provide eyewash station and cartridges that are products of a single manufacturer.
- B. Acceptable Manufacturer/ Product: Honeywell Safety Products, Fendall Pure Flow 1000 or approved equal.

2.3 FACTORY ASSEMBLY

- A. Provide one eyewash station complete with eyewash fluid in each substation.
- B. Install eyewash station in accordance with manufacturer instructions immediately adjacent to battery installation. Locations shall meet requirements of ANSI Z358.1.
- C. Install eyewash solution cartridge(s) in accordance with manufacturer instructions.
- D. Provide translucent 6-mil polyethylene sheeting as a secure and dust-proof, temporary cover over each completed eyewash station.

PART 3 - EXECUTION

3.1 FIELD INSTALLATION

- A. Requirements of Article titled "Factory Assembly" apply to field installation.
- B. Provide factory-sealed eyewash saline assembly upon delivery of substation to site. Assembly shall have minimum 22-months shelf life remaining at time of delivery.

3.2 SITE QUALITY CONTROL

- A. Remove temporary cover after final commissioning of substation and verify that eyewash station is clean and ready to use.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

- A. The quantities of accepted work will be measured in the following units. All measurements will be plan measure except for authorized changes.
 - 1. Description: Lump Sum

4.2 PAYMENT

- A. Payment will be made at the respective unit or lump-sum price listed in the proposal and shall be full compensation for all labor, materials, and equipment necessary to complete the respective unit in place. There will be no separate measurement or payment for any item of work not specifically identified and listed in the proposal, and all such work shall be considered a subsidiary item with all costs pertaining thereto included in the prices for other items listed in the proposal. At the Engineer's option, partial payment may be made for any lump sum item listed in the proposal, providing that the Contractor is diligently and satisfactorily pursuing full completion of such partially complete item in accordance with the approved job progress schedule.

END OF SECTION

SECTION 34 21 12

LOW-VOLTAGE PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Circuit breaker panel boards, including dc distribution panelboard.
 - 2. Enclosed circuit breakers.

1.2 RELATED SECTIONS

- A. SECTION 34 21 05 – Common Work Results for TES
- B. SECTION 34 21 06 – TES Common Work Results for Metals

1.3 REFERENCED STANDARDS

- A. Section incorporates by reference the latest revisions of the following documents:
- B. ASTM International (ASTM)
 - 1. ASTM B187, Specification for Copper Bar, Bus Bar, Rod and Shapes
- C. National Electrical Manufacturers Association (NEMA)
 - 1. NEMA PB 1, Panelboards
 - 2. NEMA 250, Enclosures for Electrical Equipment (1000 Volts Maximum)
- D. National Fire Protection Association (NFPA)
 - 1. NFPA 70, National Electrical Code (with City of El Paso amendments)
- E. Underwriters Laboratories Inc. (UL)
 - 1. UL 67, Panelboards
 - 2. UL 489, Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures

1.4 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Product Data:
 - 1. Circuit breakers.
 - 2. Circuit breaker identification.

- C. Shop Drawings:
1. Submit shop drawings and electrical diagrams as follows:
 - a. Panelboards and Load Centers:
 - 1) Show general arrangement, location and identification of the enclosure.
 - 2) Identify each circuit.
 - 3) Show location and identification of terminals.
 - 4) Show location of barriers.
 - 5) Furnish wiring diagrams.
 - b. Circuit Breakers: Show circuit for which intended, voltage ratings, insulation level, current rating and interrupting ratings.
- D. Operation and Maintenance Data:
1. Submit manufacturer's operating and maintenance instructions on products specified in this Section, including the following:
 - a. Description of the switchboard and its components.
 - b. Manufacturer's operating and maintenance instructions, parts list, illustrations and diagram for components.
 - c. Recommended list of spare parts.
 - d. Wiring diagram.
 - e. Electrical characteristics of each component including relays or solid-state circuitry.
- E. Factory Test Reports: Submit copies of certified reports of factory tests performed in accordance with the applicable referenced standards and specification requirements.

1.5 QUALITY ASSURANCE

- A. Comply with the requirements of the Project Quality Plan.
- B. Qualifications: Manufacturer that has been regularly engaged in the manufacture of similar equipment and meets UL requirements.
- C. Conform to UL 489, NEMA PB 1, and NFPA 70, as applicable.
- D. Components of the same type, size, rating, functional characteristics and manufacture shall be interchangeable.
- E. Each item shall be UL labeled.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Ship each unit securely wrapped, packaged and labeled for safe handling in shipment and to avoid damage or distortion.
- B. Store in secure and dry storage facility.

PART 2 - PRODUCTS**2.1 PANELBOARDS AND LOAD CENTERS**

- A. Comply with NEMA PB 1 and UL 67.
- B. Enclosure:
1. NEMA 250 Type 1, fabricated from galvanized steel, surface-mounted unless otherwise indicated, tamperproof.
 2. Gutter size:

Main Bus Rating (Amperes)	End Gutter Size (Inches)	Side Gutter Size (Inches)
225 and below	6	5
400 and over	8	8

3. Provide backplate of reinforced steel for mounting of interior components.
 4. Provide device or mechanism for enclosure grounding.
 5. Dead-front type.
- C. Cover and Trim:
1. Designed for surface mounting.
 2. Door:
 - a. Hinged, fitted with a combination latch and door lock, accommodating a master key.
 - b. Provide one flat key tumbler cylinder-type, nickel-plated door lock conforming to the station master key system, two keys per lock.
 3. Circuit Directory: Provide a directory frame with acrylic plastic face mounted on the back of the door.
 4. Finish: Powder coat as specified in Section 34 21 06, TES Common Work Results for Metals.
- D. Bus Bars:
1. ASTM B187, 98 percent conductivity copper, with silver-plated contact surface.
 2. Provide neutral bus of the same rating as that of phase bus.
 3. Provide a full-rated separate grounding bus.
- E. Circuit Breakers: Bolt-on type complying with UL 489.
- F. Additional Requirements for TES Substation Ac Auxiliary Panel:
1. Provide main breaker in panel.

2. If panel is not located on face of switchgear, provide an additional main breaker accessible from the front of switchgear without opening a compartment.
- G. Additional Requirements for Dc Panelboards:
1. Designed for two-wire, 125 Vdc ungrounded power distribution service.
 2. Circuit breakers: Two-pole, 10,000 A interrupting rating at 250 Vdc minimum.
- H. Identification: Provide nameplate or other machine-made permanent identification for each circuit breaker, giving each a unique sequential number.

2.2 ENCLOSED CIRCUIT BREAKERS

- A. Molded case, bolt-on type, quick-make quick-break, with thermal-magnetic type overload trip, interchangeable unit for frame rated 125 A and above, complying with UL 489.
- B. Enclosure: NEMA 250 Type 12, fabricated from galvanized steel, surface-mounted unless otherwise indicated.
- C. Finish: Powder coat as specified in Section 34 21 06, TES Common Work Results for Metals.

2.3 FACTORY ASSEMBLY

- A. Mounting Height: Locate top 6 feet, 6 inches above finished floor and the bottom not less than 12 inches above finished floor, unless specifically indicated otherwise.
- B. Anchor in accordance with seismic requirements in Section 34 21 05, Common Work Results for TES.
- C. Identification:
1. Mount sequential numbers directly on each circuit breaker or on the cover or trim adjacent to each breaker.
 2. Provide each panelboard and load center with an accurate, printed circuit directory.
 - a. Identify each circuit, spare breakers, and spaces.
 - b. Numbers on circuit directory must correspond to sequential numbers mounted on each breaker.
 - c. Install in the factory provided directory frame mounted on the back of the door.

2.4 SOURCE QUALITY CONTROL

- A. In addition to the manufacturer's standard tests, as a minimum perform the following tests at the manufacturer's plant:
1. 60 Hz dielectric tests
 2. Mechanical operations tests
 3. Electrical operation tests

PART 3 - EXECUTION**3.1 FIELD INSTALLATION**

- A. Requirements in Article titled "Factory Assembly" apply to field installation.

PART 4 - MEASUREMENT AND PAYMENT**4.1 MEASUREMENT**

- A. The quantities of accepted work will be measured in the following units. All measurements will be plan measure except for authorized changes.

1. Description: Lump Sum

4.2 PAYMENT

- A. Payment will be made at the respective unit or lump-sum price listed in the proposal and shall be full compensation for all labor, materials, and equipment necessary to complete the respective unit in place. There will be no separate measurement or payment for any item of work not specifically identified and listed in the proposal, and all such work shall be considered a subsidiary item with all costs pertaining thereto included in the prices for other items listed in the proposal. At the Engineer's option, partial payment may be made for any lump sum item listed in the proposal, providing that the Contractor is diligently and satisfactorily pursuing full completion of such partially complete item in accordance with the approved job progress schedule.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 34 21 13

TES SWITCHBOARDS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Switchboard to feed rectifier transformer in VMF.
 - 2. Protective relays.
 - 3. Meters and current transformers.

1.2 RELATED SECTIONS

- A. SECTION 34 21 05 – Common Work Results for TES
- B. SECTION 34 21 06 – TES Common Work Results for Metals
- C. SECTION 34 21 17 – TES Substation Design and Assembly
- D. SECTION 34 21 31 – TES Substation Automation System (SAS)
- E. SECTION 34 21 80 – TES Spare Parts and Special Tools
- F. SECTION 34 21 90 – TES Testing

1.3 REFERENCED STANDARDS

- A. Section incorporates by reference the latest revisions of the following documents:
- B. ASTM International (ASTM)
 - 1. ASTM A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
- C. Institute of Electrical and Electronics Engineers (IEEE)
 - 1. IEEE C57.13, Standard Requirements for Instrument Transformers
- D. National Electrical Contractors Association (NECA)
 - 1. NECA 400, Standard for Installing and Maintaining Switchboards
- E. National Electrical Manufacturer's Association (NEMA)
 - 1. NEMA AB1, Molded-Case Circuit Breakers, Molded Case Switches, and Circuit-Breaker Enclosures
 - 2. NEMA PB 2, Deadfront Distribution Switchboards
- F. National Fire Protection Association (NFPA)
 - 1. NFPA 70, National Electrical Code

1.4 SUBMITTALS

- A. Procedures: Section 01 33 00, Submittal Procedures.
- B. Product Data:
 - 1. Submit manufacturers' product data for specified equipment and materials. Include the following information for each item:
 - a. Manufacturer's model number or item identification.
 - b. UL listing and rating.
 - c. Critical dimensions and mounting arrangement.
 - d. Replacement parts list.
- C. Spare Parts and Special Tools:
 - 1. Submit a list of spare parts to be provided under this Section.
 - 2. Submit at the same time as product data.
 - 3. Provide part numbers for each part, including a detailed break down of each spare part assembly and set, as defined in Section 34 21 80, TES Spare Parts and Special Tools.
 - 4. Submit a list of special tools to be provided under this Section, as defined in Section 34 21 80, TES Spare Parts and Special Tools.
- D. Shop Drawings:
 - 1. Show materials and methods of construction, door arrangement, conduit hubs and knockout locations.
 - 2. Circuit Breakers: Show circuit for which intended, voltage ratings, insulation level, current rating and interrupting ratings.
 - 3. Single line diagrams.
 - 4. Physical arrangement drawings and weight of equipment and major components.
 - 5. Unit wiring diagrams.
 - 6. Circuit breakers, controls and indications.
 - 7. Show space available for conduit and bus duct entrance and for routing and training of cables.
 - 8. Schematic diagrams for electrically operated equipment.
 - 9. Setting diagrams and templates if anchoring in concrete is required.
 - 10. Assembly and erection diagrams if shipped in sections or if some parts are shipped separately and not installed at the factory.
 - 11. Interconnection diagrams for circuits having externally located instruments, controls, alarms, or similar devices.

- E. Calculations: Submit sizing calculations for protection current transformers and metering current transformers. Obtain Engineer's approval before procuring current transformers.
- F. Testing:
 - 1. Submit test procedures that meet the requirements of Section 34 21 90, TES Testing, for the following:
 - a. Factory Design Tests.
 - b. Factory Production Tests.
 - 2. Submit test reports that meet the requirements of Section 34 21 90, TES Testing, for the following:
 - a. Factory Design Tests.
 - b. Factory Production Tests.
- G. Operation and Maintenance Data:
 - 1. Submit manufacturer's operating and maintenance instructions on products specified in this Section.
 - 2. Submit immediately after approval of product data.

1.5 SPARE PARTS

- A. Provide spare parts in accordance with Section 34 21 80, TES Spare Parts and Special Tools.
- B. List below applies to items in this Specification Section:
 - 1. Switchboard circuit breaker: Provide 1 spare.
 - 2. Circuit breaker operating mechanism charging motor: Provide 1 spare.
 - 3. Circuit breaker operating mechanism spring: Provide 1 spare assembly.
 - 4. Circuit breaker solenoids: Provide 1 spare set.
 - 5. Metering current transformers: Provide 1 spare set.
 - 6. Protection current transformers: Provide 1 spare set.
 - 7. Potential transformers: Provide 1 spare set.
 - 8. Potential transformer primary and secondary fuses: Provide 1 spare set.
 - 9. Ac protective relays (non-IED): Provide 1 spare set.
 - 10. Ac switchgear IEDs: Provide 1 spare set.
 - 11. Ac ammeter and voltmeter: Provide 1 spare set if separate from IEDs.
 - 12. Switchboard control circuit mini-breakers: Provide 1 spare set.
 - 13. Transducers: Provide 1 spare set.
 - 14. Indicating LEDs, including those for trip circuit monitor: Provide 1 spare set.

1.6 QUALITY ASSURANCE

- A. Comply with the requirements of the Project Quality Plan.
- B. Qualifications: Manufacturer that has been regularly engaged in the manufacture of similar equipment and meets UL requirements.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Shipping:
 - 1. If approved by the Engineer, switchboards may be broken down into convenient shipping sections after tests are completed.
 - 2. Shipping split terminals and connections disconnected for shipping shall be properly identified and protected.

PART 2 - PRODUCTS**2.1 GENERAL REQUIREMENTS**

- A. Metal-enclosed, self-supporting, dead front, freestanding, circuit-breaker type for indoor service.
- B. Comply with NEMA PB 2, NFPA 70, as applicable.
- C. Each item shall be UL labeled.
- D. Provide the required number of vertical sections designed for bolting together to form a rigid switchboard.
- E. Switchboards shall be assembled, wired and tested at the manufacturer's plant.
- F. Components of the same type, size, rating, functional characteristics and manufacture shall be interchangeable.

2.2 RATINGS

- A. Current rating: Based on operation in a 25 degree C room ambient and as required for the load.
- B. Bus bracing: 100 kA RMS momentary.

2.3 ENCLOSURE

- A. Type:
 - 1. Freestanding, reinforced with adequate steel framework to form a rigid structure.
 - 2. Designed for group assembly as part of complete switchgear.
- B. Physical Size:
 - 1. Maximum 90 inches high.
 - 2. Width and depth adequate to accommodate and connect the equipment.
 - 3. Adequate space to accommodate bending radius requirements of cables.

- C. Material: Zinc-coated steel sheet conforming to ASTM A653/A653M, zinc coating designation G90.
- D. Workmanship: Fabricate with a smooth outer surface free from burrs, ridges and other blemishes.
- E. Finish:
 - 1. Powder coat as specified in Section 34 21 06, TES Common Work Results for Metals.
 - 2. Color: Refer to Section 34 21 06, TES Common Work Results for Metals.
- F. Configuration: Align vertical sections front and rear.
- G. Barriers: Switchboards in the same line-up fed electrically from different feeders shall have barriers such that a fire caused by an internal fault at one switchboard shall not spread to another switchboard.
- H. Access: Equip with front doors and front or side access panels.
- I. Nameplates:
 - 1. Provide a nameplate on each switchboard and its components and devices as specified in Section 34 21 17, TES Substation Design and Assembly.
 - 2. Label each control switch and pilot light with one inch wide nameplate showing the function and the number of unit in 1/2-inch high letters.

2.4 SWITCHBOARD BUSES

- A. Bus: Silver-plated copper buses of sufficient size to limit the current density to 750 A per square-inch cross section.
- B. Main Buses:
 - 1. Extend main buses horizontally from the incoming line sections to all distribution sections if indicated on the same line-up.
 - 2. Make provision for extending the main buses for future vertical sections.
- C. Section Buses: Extend section buses vertically from the main bus through each vertical section.
- D. Neutral bus: Fully rated.
- E. Ground Buses:
 - 1. Extend a ground bus through the length of the switchboard.
 - 2. Firmly bolt to each vertical section in at least two places.
 - 3. Make provision for connection to the building or station grounding system near each end of the ground bus.
 - 4. Make provision for future extension of the ground bus.
- F. Phasing: Phase buses A-B-C from left-to-right, top-to-bottom and front-to-rear as viewed from the front of the switchboard.

2.5 SWITCHBOARD CIRCUIT BREAKERS

- A. Type: Draw-out, insulated-case, stored energy, electrically operated, three phase, 60 Hz, in accordance with NEMA AB 1.
- B. Closing time: Maximum five cycles.
- C. Insulation rating of plug shall be the same as the breaker rating.
- D. Circuit breakers shall be capable of performing 4,000 close-open cycles at rated load, 80 percent power factor and rated voltage and 4,000 close-open cycles at no load without maintenance or replacement of parts.
- E. Breakers shall have control power and motor charging device of 125 Vdc.
- F. Breakers shall be equipped with field-replaceable contacts.

2.6 PROTECTIVE RELAYS

- A. Ac Protective Relay - Intelligent Electronic Device (IED):
 - 1. For each ac breaker provide a multi-function protective relay IED and related transducers. Device shall have an onboard HMI useful for viewing breaker stations and adjusting protective relay settings.
 - 2. IED shall communicate with the SAS via protocol specified in Section 34 21 31, TES Substation Automation System (SAS).
 - 3. Provide the following functions, at minimum:
 - a. Ac undervoltage (ANSI Device 27):
 - 1) Primary function: Trip and annunciate when the ac input voltage drops to 80 percent of nominal voltage. Setpoint shall be field adjustable.
 - 2) Relay shall also trip and annunciate upon loss of voltage due to utility outage.
 - 3) Relay shall contain field adjustable time delay.
 - b. Phase sequence relay (ANSI Device 47):
 - 1) Three-phase voltage protective relay connected to provide open phase protection.
 - 2) This relay shall contain a field adjustable time delay.
 - c. Ac overvoltage (ANSI Device 59):
 - d. Phase fault time overcurrent (ANSI Device 50/51):
 - 1) Primary function shall be to provide overload and fault protection for loads served.
 - 2) Relay shall be designed to compile a composite time overcurrent characteristic curve which shall best match the normal and overload requirements of the load and to match the thermal and mechanical withstand of transformers.

- 3) Relay shall provide for both instantaneous and time delay overcurrent protection.
 - e. Ground fault time overcurrent (ANSI Device 50N/51N):
 - 1) A residual instantaneous and time delay relay connected to provide sensitive ground fault detection.
 - 2) This relay shall be field adjustable.
 - f. Control/Position of ac breaker (ANSI Device 52).
 - g. Reverse Power (Device 32):
 - 1) Provide in incoming feeder cubicle connecting to utility service switchgear.
 - 2) This device shall trip and lock-out associated circuit breaker when it detects a flow of power from substation back toward the utility.
 - h. Local/Remote control (Device 43)
 4. Device shall have chart recording features with PC software used for downloading and analyzing faults. Transient fault recording function shall capture analog and digital pre-fault and post-fault waveforms and data. Fault recording shall be stored in non-volatile memory.
- B. Lockout (Device 86):
1. Provide on the ac circuit breaker compartment.
 2. Reset switch handle:
 - a. Heavy-duty switchboard type pistol-grip handle.
 - b. Acceptable Manufacturer: Electroswitch or approved equal.
 3. Provide indication of "lockout" and "normal" at the reset switch.
 4. When circuit breaker is tripped by lockout relay, it shall remain locked out until manually reset.
- C. Provide other protective relaying functions as indicated on one-line diagram in Contract Drawings.
- D. Trip Circuit Monitors:
1. Provide a trip circuit monitor for monitoring coil in the tripped and reset position for each of the following:
 - a. Circuit breaker trip coil.
 - b. Lockout relay trip coil.
 2. Indication and Operation:
 - a. Green LED that illuminates when the trip coil is energized and turns off when the coil is de-energized.
 - b. NO and NC Form C contacts for indication of a failed trip coil.

- c. Red LED that illuminates upon failure of the trip coil. This indication shall illuminate under no condition other than an unhealthy coil.
- d. 200 millisecond delay to allow for auxiliary contacts to transfer.
- e. LEDs:
 - 1) Plug-in replaceable with a life of 100,000 hours.
 - 2) Protected against reverse polarity by a diode.
- f. Control Power: 125 Vdc.

2.7 POWER METER

- A. Capable of revenue-accuracy metering of electrical parameters including voltage, current, frequency, power factor, kW, kVAR, kWh, and kVAh, and values of kW and kVA demand.
- B. MV90 compatible: Programmable to mimic values metered by KCP&L during a 15-minute sliding window.
- C. Features: Data logging, internal web server, 4 MB of internal memory.
- D. Communications:
 - 1. Modbus TCP/IP Ethernet.
 - 2. Monitor with SAS. Electrical parameters shall be viewable at the SAS HMI, as specified in Alarm Points List in Section 34 21 31, TES Substation Automation System.
- E. Approved Manufacturer/Product: Electro Industries/GaugeTech, Shark 200, or approved equal.

2.8 INSTRUMENT TRANSFORMERS

- A. Instrument transformers shall conform to IEEE C57.13, with the additional requirements indicated below.
- B. Current transformers:
 - 1. Shall be capable of withstanding thermal and mechanical ratings of the circuit breaker.
 - 2. Molded-rubber or epoxy construction, wound-type or bushing-mounted.
 - 3. Wound-type current transformers:
 - a. Provide separate compartment isolated from the control panel and all other equipment.
 - b. Provide a mounting frame that bolts securely to the switchgear frame.
 - c. Full-wave impulse insulation level: 125 kV.
 - d. Secondary terminal blocks shall have covers with integral shorting bars and secondary wiring shall be run to readily identifiable terminal block points in the control compartment.

- e. Terminal block points shall also have integral shorting bars for the current transformer leads.
- 4. Bushing-type current transformers: Low-voltage, ring-core, high-accuracy type designed for secure mounting on the primary contact support bushings.
- 5. Accuracy:
 - a. Protective relaying: Relaying accuracy classification, under the burdens imposed by the specified devices.
 - b. Power Meters: Accuracy Class 0.3 at burden B-0.5.
 - 1) If this metering accuracy is not available, perform an analysis of expected accuracy of metering equipment for loads from 1 percent to 150 percent of actual load rating and submit for approval.
 - 2) Bushing current transformers that will not provide accuracy of plus or minus 0.6 percent at 1 percent load and plus or minus 1.0 percent at full load will be rejected and require installation of wound-type current transformers.
- 6. Submit sizing calculations for protection current transformers and metering current transformers.
- 7. Provide separate sets of current transformers for protective relaying and metering.
- C. Potential Transformers:
 - 1. Molded-rubber or epoxy construction.
 - 2. Transformers shall have full-wave impulse insulation level of 10 kV.
 - 3. Primary and secondary circuits of potential transformers shall be fused by means of non-renewable cartridge-type fuses.

2.9 SOURCE QUALITY CONTROL

- A. Factory Production Tests:
 - 1. Meters, Instruments and Instrument Transformers:
 - a. Check for accuracy, performance and operation in accordance with IEEE C57.13.
 - 2. Power Meter: Test accuracy and functionality.
 - 3. In addition to the manufacturer's standard tests, as a minimum perform the following tests at the manufacturer's plant:
 - a. 60 Hz dielectric tests.
 - b. Mechanical operations tests.
 - c. Grounding of instruments.
 - d. Transformer case tests.
 - e. Electrical operation tests.

- f. Control wiring checks.

PART 3 - EXECUTION

3.1 FIELD INSTALLATION

- A. Install switchboards in locations indicated on Contract Drawings in accordance with NECA 400.
- B. Anchor in accordance with seismic requirements in Section 34 21 05, Common Work Results for TES.
- C. Install supporting members, fastenings, framing, hangers, bracing, brackets, straps, bolts and angles as required to set and rigidly connect the switchboard.
- D. Power Meter: Connect to SAS via Ethernet (see Section 34 21 31, TES Substation Automation System (SAS)). Test to verify connectivity using the Engineering Laptop.
- E. Field Touch up Painting:
 - 1. After installations are complete, thoroughly clean surfaces where shop finish is damaged, including bolts, nuts, washers and welds and refinish each item with the same coating system as used for shop coating.
 - 2. Provide matching touch-up coating by approved spray methods, or by brush where approved.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

- A. The quantities of accepted work will be measured in the following units. All measurements will be plan measure except for authorized changes.
 - 1. Description: Lump Sum

4.2 PAYMENT

- A. Payment will be made at the respective unit or lump-sum price listed in the proposal and shall be full compensation for all labor, materials, and equipment necessary to complete the respective unit in place. There will be no separate measurement or payment for any item of work not specifically identified and listed in the proposal, and all such work shall be considered a subsidiary item with all costs pertaining thereto included in the prices for other items listed in the proposal. At the Engineer's option, partial payment may be made for any lump sum item listed in the proposal, providing that the Contractor is diligently and satisfactorily pursuing full completion of such partially complete item in accordance with the approved job progress schedule.

END OF SECTION

SECTION 34 21 14**TES MEDIUM-VOLTAGE AC CIRCUIT-BREAKER SWITCHGEAR****PART 1 - GENERAL****1.1 SUMMARY**

- A. This Section includes the following:
 - 1. Metal-clad, medium-voltage ac circuit breaker switchgear for TES substation primary protection.
 - 2. Incoming fusible, load break disconnect switch.
 - 3. Utility metering equipment.

1.2 RELATED SECTIONS

- A. SECTION 34 21 06 – TES Common Work Results for Metals
- B. SECTION 34 21 17 – TES Substation Design and Assembly
- C. SECTION 34 21 18 – TES Lighting
- D. SECTION 34 21 31 – TES Substation Automation System (SAS)
- E. SECTION 34 21 73 – TES Studies
- F. SECTION 34 21 80 – TES Spare Parts and Special Tools
- G. SECTION 34 21 90 – TES Testing
- H. SECTION 34 21 95 – TES Operation and Maintenance Data

1.3 DEFINITIONS

- A. Intelligent Electronic Device (IED): Refers to any digital or numerical-based protection, metering, control, or monitoring device that has processing, recording and reporting capabilities and a local human machine interface (HMI); used in electrical switchgear.

1.4 REFERENCED STANDARDS

- A. Section incorporates by reference the latest revisions of the following documents:
- B. American National Standards Institute (ANSI)
 - 1. ANSI C39.1, Requirements for Electrical Analog Indicating Instruments
- C. Institute of Electrical and Electronics Engineers (IEEE)
 - 1. IEEE 242, Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems
 - 2. IEEE 1653.2, Standard for Uncontrolled Traction Power Rectifiers for Substation Applications Up to 1500 Vdc Nominal Output

3. IEEE C37.06, Standard for Ac High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis-Preferred Ratings and Related Required Capabilities for Voltages Above 1000 V
 4. IEEE C37.09, Standard Test Procedure for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis
 5. IEEE C37.12, Guide for Specifications of High-Voltage Circuit Breakers (over 1000 Volts)
 6. IEEE C37.20.2, Standard for Metal-Clad Switchgear
 7. IEEE C37.20.3, Standard for Metal-Enclosed Interrupter Switchgear
 8. IEEE C37.46, Standard Specifications for High Voltage (> 1000 V) Expulsion and Current-limiting Power Class Fuses and Fuse Disconnecting Switches
 9. IEEE C37.90, Standard for Relays and Relay Systems Associated with Electric Power Apparatus
 10. IEEE C37.90.1, Standard Surge Withstand Capability (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus
 11. IEEE C57.13, Standard Requirements for Instrument Transformers
- D. Kansas City Power & Light (KCP&L)
1. KCP&L S3, Point of Delivery Requirements for Privately Owned Substations, 15 kV Class
 2. KCP&L S8, Metering Transformer Installation in Metal-Clad Switchgear – 15 kV and Below
- E. National Electrical Contractors Association (NECA)
1. NECA 430, Standard for Installing Medium-Voltage Metal-Clad Switchgear

1.5 SUBMITTALS

- A. Procedures: Section 01 33 00, Submittal Procedures.
- B. Product Data: Catalog data and other pertinent information concerning design and application ratings, service performance, and reliability, including the following:
1. Complete details of circuit breakers, drawout mechanism, manual racking handle, and interface with drawout mechanism.
 2. Relays.
 3. Control switches.
 4. Indicating lamps.
 5. Protective devices.
 6. Surge arresters.
 7. Cubicle heaters and humidistat.
 8. Protection devices with coordination curves and setting procedures.

- C. Spare Parts and Special Tools:
 - 1. Submit a list of spare parts to be provided under this Section.
 - 2. Submit at the same time as product data.
 - 3. Provide part numbers for each part, including a detailed break down of each spare part assembly and set, as defined in Section 34 21 80, TES Spare Parts and Special Tools.
 - 4. Submit a list of special tools to be provided under this Section, as defined in Section 34 21 80, TES Spare Parts and Special Tools.
- D. Shop Drawings:
 - 1. Manufacturer's detailed, dimensioned drawings for each type of switchgear assembly.
 - 2. Manufacturer's schematic wiring and interconnection diagrams.
- E. Operation and Maintenance Data:
 - 1. Manufacturer's operating and maintenance instructions, parts list, illustrations and diagram for components.
 - 2. Recommended list of spare parts.
 - 3. Submit immediately after approval of product data

1.6 SPARE PARTS

- A. Provide spare parts in accordance with Section 34 21 80, TES Spare Parts and Special Tools.
- B. List below applies to items in this Specification Section:
 - 1. Ac circuit breaker, complete with truck: Provide 1 spare.
 - 2. Circuit breaker operating mechanism charging motor: Provide 2 spares.
 - 3. Circuit breaker operating mechanism spring: Provide 2 spare assemblies.
 - 4. Circuit breaker solenoids: Provide 2 spare sets.
 - 5. Metering current transformers: Provide 1 spare set.
 - 6. Protection current transformers: Provide 1 spare set.
 - 7. Potential transformers: Provide 1 spare set.
 - 8. Potential transformer primary and secondary fuses: Provide 1 spare set.
 - 9. Ac protective relays (non-IED): Provide 1 spare set.
 - 10. Ac switchgear IEDs: Provide 1 spare set.
 - 11. Ac ammeter and voltmeter: Provide 1 spare set if separate from IEDs.
 - 12. Ac switchgear control circuit mini-breakers: Provide 3 spare sets.

13. Transducers: Provide 1 spare set.
14. Indicating LEDs, including those for trip circuit monitor: Provide 1 spare set.

1.7 QUALITY ASSURANCE

- A. Comply with the requirements of the Project Quality Plan.
- B. The ac metal clad switchgear shall be UL labeled or shall be furnished with a Field Evaluation label in accordance with Section 34 21 17, TES Substation Design and Assembly.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Ac switchgear shall form a line-up of dead-front, totally enclosed, free-standing switchgear suitable for indoor service, and include an incoming disconnect switch, utility metering, and a circuit breaker to feed rectifier transformer.
- B. Switchgear shall be metal-clad and conform to the requirements of IEEE C37.20.2, except as otherwise indicated.

2.2 RATINGS

- A. Ac switchgear shall have the following ratings:
 1. Nominal Voltage: 13.2 kV.
 2. Maximum Voltage: 15 kV rms.
 3. Frequency: 60 Hz.
 4. Insulation Level, 60 Hz Withstand: 36 kV.
 5. Insulation Level, Impulse Withstand: 95 kV.
 6. Continuous Current: 1200 A.
 7. Rated Short Circuit Current: 25 kA.
 8. Maximum Dimensions: 36 inches wide, 96 inches deep, 95 inches high or as indicated.

2.3 AC SWITCHGEAR STRUCTURE

- A. Construction:
 1. Rigid, self-supporting, and self-contained.
 2. Structural elements electrically welded or bolted together.
 3. Sheet steel, minimum 11 gage.
 4. Shall support equipment under normal loads, short-circuit conditions, and specified seismic conditions.
 5. Ac switchgear enclosure shall be divided, barriered, and partitioned into separate vertical sections.

6. Finish: Powder coat in accordance with Section 34 21 06, TES Common Work Results for Metals.
- B. Circuit Breaker Compartments:
1. Design to allow draw-out circuit breakers to be easily drawn in or out of their housing.
 2. Provide guide rails or cradles for positioning the removable elements as an integral part of the equipment. Guides shall ensure proper alignment.
 3. Provide self-aligning, self-coupling, primary and secondary disconnecting devices that allow the draw-out breakers to connect or disconnect from the buses and auxiliary circuits.
 4. Connection of control wiring to the ac breaker shall be by sliding contacts. A plug-style disconnect is acceptable, provided the breaker cannot be mechanically racked into the connected position with the plug disconnected.
 5. Provided automatic protective shutters to cover live medium-voltage terminals and prevent accidental contact with live parts as the removable element of breaker is drawn out of the cubicle.
 6. Provide a manual racking mechanism for horizontal draw-out of each circuit breaker:
 - a. Mechanism shall have three circuit breaker positions: Disconnected, test, and connected.
 - b. Provide positive stops to prevent over-travel at each position with labels clearly identifying the breaker's position.
 - c. Mechanism shall be designed for racking of circuit breaker in and out of connected and disconnected position with the compartment front door in the closed and latched position.
 - 1) With door closed and latched, the socket for insertion of manual racking handle shall be within 1 inch of face of door for ease of use. An extension on the socket may be provided to satisfy this requirement.
 - 2) An arrangement that makes it difficult to align the manual racking handle with the socket without opening the door is not acceptable.
 - d. Manual racking handle:
 - 1) Handle shall be designed such that it does not require a user with special skills to insert or operate.
 - 2) Provide a universal joint if necessary to prevent the user from knocking his knuckles on the floor while racking a breaker.
 - 3) Engineer may reject manual racking handle after delivery if it has not been designed for ease of use. If rejected, provide a handle that addresses the use issues at no additional cost to the City.
 - 4) Provide one at each switchgear location.

-
7. Breaker case and frame shall be grounded when the breaker is in the connected and test positions by means of positive contact with a copper ground bus.
 8. Provide the following interlocks:
 - a. Prevent either electrical or manual operation of the breaker unless it is in the connected or test position.
 - b. A positive mechanical interlock shall prevent racking in or out unless the breaker is in the OPEN position.
 - c. Circuit breaker, complete with the operating mechanism shall be capable of being removed from the enclosure only in the disconnected position.
- C. Control/ Terminal Board Compartment:
1. Controls, including programmable controllers, instrumentation, control relays, terminal boards, control wiring and control devices shall be housed in a separate control/terminal board compartment.
 - a. Compartment shall be barriered from the power wiring and buswork compartments.
 - b. Exception: Where controls and terminal boards are dedicated to circuit breaker function, they may be located in the circuit breaker compartment.
 2. Protective relays, meters, instruments and control devices shall be mounted on front compartment doors and shall be located such that meters and displays can be operated and read by a person standing at floor level.
- D. Access Doors:
1. Access to all components shall be from the front and the rear.
 2. Equipment access panels located on the side or top of the enclosures are prohibited.
 3. Provide each compartment with separate hinged front and rear access doors for servicing.
 4. Opening of any front door shall not expose circuits in adjacent compartments.
 5. Construction:
 - a. Sheet steel, 11 gage minimum.
 - b. Reinforce against distortions using suitable flanges and stiffening members.
 6. Hinges: Stainless steel heavy-duty type.
 7. Latches:
 - a. Doors shall be securely fastened in the closed position with a three point latch easily opened without the use of tools.
 - b. Two latches will be allowed if front panel consists of more than one full-length door.

8. Handles: Provide each door with a heavy duty-handle with provisions for a padlock.
 9. Door Stops: Provide each door with a heavy-duty stop to hold it securely in the open position.
- E. Heaters: Provide two strip-type heaters in each switchgear cubicle to prevent condensation.
1. Operating voltage for heating strips shall not exceed 50 percent of heater rated voltage.
 2. Provide an individual humidistat in each cubicle to control heaters.
 3. Locate humidistat in an area of each cubicle so that it can measure the average humidity in the cubicle.
 4. Provide a digital heater ammeter on the front of each cubicle enclosure to indicate current and operation of heaters.
- F. Lights: Provide a light in each cubicle in accordance with Section 34 21 18, TES Lighting.
- G. Warning Signs:
1. Front Access Doors: Sign on each stating "DANGER: LIVE PARTS" and "DANGER: HIGH VOLTAGE."
 2. Rear Access Doors: Sign on each stating "DANGER: LIVE PARTS" and "DANGER: HIGH VOLTAGE."

2.4 BUSES AND CONNECTIONS

- A. Power Bus:
1. Material: Silver-plated, electrical grade copper.
 2. Continuous current rating: Minimum 1200 A for main bus and circuit breaker connections.
- B. Ground Bus:
1. Material: Electrical grade copper.
 2. Size: Minimum 2 inch by 1/4 inch.
 3. Extend the full length of ac switchgear assembly and bond to each switchgear section by solidly bolting the bus to a non-removable structural member.
- C. Main Bus:
1. Extend three-phase horizontal bus the full length of ac switchgear assembly.
 2. Insulate entire length of main bus, including joints, with 30 kV, flame-retardant, non-hygroscopic, track-resistant insulation free from internal voids.
 3. Corona Prevention:
 - a. There must not be air gaps between the bus and the bus insulation.

- b. Where bus passes through cubicle barriers, there must not be air gaps between the bus insulation and the opening through which it passes.
- D. Connections:
- 1. Silver-plated, electrical grade copper bus.
 - 2. Connections include but are not limited to bus taps, circuit breaker connections, CT and PT connections, transformer connections, and surge arrester connections.
 - 3. Join with a minimum of two bolts per joint and Belleville washers. Hardware shall be silicon bronze.
 - 4. Cable connections are not permitted.
- E. Buses and bus connections shall be adequate to withstand thermal and mechanical stresses associated with short-circuit currents equal to the momentary and three-second rating of the circuit breaker.

2.5 INCOMING DISCONNECT SWITCH SECTION

- A. Description: Load break, fusible, airbreak disconnect switch, meeting the requirements of KCP&L S3.
- B. Switch Cubicle:
- 1. Mechanical Interlock:
 - a. The switch must be open before the door can be opened.
 - b. The door must be closed before the switch can be closed.
 - 2. Observation Window: Ample sized, high-impact, gasketed, positioned so that position of all three switches can easily be seen through the closed door.
 - 3. Safety Barrier: Metal, grounded, bolted closed in front of switch to prevent inadvertent contact with live parts; barrier must allow full-view inspection of the switch blade position.
 - 4. Operating Mechanism Cover: Hinged, with quarter turn nylon latches, to discourage casual tampering.
 - 5. Switch Position Indicators:
 - a. Green LED with label "OPEN"
 - b. Red LED with label "CLOSED"
 - 6. Locking Provisions: Suitable for padlocking switch in the open or closed position.
- C. Switch:
- 1. Switching mechanism:
 - a. Three-pole, gang-operated.
 - b. Manual quick-make, quick-break over-toggle type not requiring use of chain or cable
 - c. Heavy-duty coil spring to provide opening and closing energy.

- d. Normal Operation: Opening and closing speed independent of the operator; not possible to tease switch into intermediate position.
 - e. Maintenance Operation: Slow closing possible to check switch blade engagement; slow opening possible to check operation of arc-interrupting contacts.
 - 2. Contacts: Separate main and break contacts for maximum endurance during fault-close and load-interrupting duty.
 - 3. Barriers:
 - a. Insulating barriers between each phase and between the outer phases and the enclosure.
 - b. Isolating barrier between operating chain and switch blades.
 - 4. Grounds:
 - a. Positive beryllium copper grounds on each phase with switch in open position.
 - b. Grounds shall be visible through viewing window.
 - 5. Switch shall be removable from the structure as a complete operational component.
- D. Fuses:
 - 1. Provide fault protection using fuses with continuous ratings as determined based on load served.
 - 2. Provide UL certification for fuse/switch integrated momentary and fault close ratings.
- E. Service Entrance:
 - 1. Make provisions for bottom (underground) service entrance and termination of the 13.2 kV incoming service cables. Conductors will be installed and terminated by KCP&L.
 - 2. Verify conduit entry locations to ensure proper termination of utility incoming cables.
 - 3. Provide a copper ground conductor equivalent to 2/0 copper minimum around the inside of the enclosure walls in the cable termination compartment and solidly ground to the ac switchgear ground bus. Provide a grounding horn for use with portable grounds.

2.6 UTILITY METERING SECTION

- A. Section shall meet requirements of Kansas City Power & Light (KCP&L) S8, referenced codes and standards, and additional requirements of KCP&L, whether published or not.
- B. Coordinate with KCP&L directly to verify requirements before preparing shop drawings.
- C. Submit switchgear shop drawings to KCP&L in accordance with KCP&L S8 and as directed by KCP&L. If clarification of submittal requirements is needed, contact KCP&L directly.

- D. Submit shop drawings to Engineer at the same time as submittal to KCP&L and obtain approval from both KCP&L and Engineer before starting manufacturing.
- E. Obtain KCP&L-furnished PTs and CTs from KCP&L and install in switchgear in accordance with KCP&L S8 and as directed by KCP&L.
- F. Furnish and install terminal blocks and PT and CT secondary wiring in accordance with KCP&L S8 and as directed by KCP&L.
- G. Enclosure access doors:
 - 1. Interior and exterior: Hinged on one side except as otherwise indicated with a two-point latch mechanism padlockable by KCP&L.
 - 2. Access doors on enclosures containing revenue metering equipment shall be labeled, "UTILITY METERING CUBICLE: NO CUSTOMER EQUIPMENT."

2.7 MEDIUM-VOLTAGE CIRCUIT BREAKER SECTION

- A. General:
 - 1. Circuit breaker shall be a draw-out type and utilize vacuum interrupters having load and fault break capabilities and shall conform to or exceed the requirements of IEEE C37.06 and IEEE C37.12.
 - 2. Circuit breakers shall be identical and physically and electrically interchangeable.
 - 3. Circuit breaker frame shall be provided with a full front metal shield to prevent access to any live primary bus or load terminals when the circuit breaker is in the connected position.
 - 4. Provide a truck or fifth wheel at each switchgear location to facilitate one-person breaker removal and turning.
 - 5. Provide means for padlocking the ac breaker in the open position.
 - 6. Circuit breaker insulation:
 - a. Noncombustible, non-hygroscopic and track-resistant.
 - b. Mechanical strength and physical characteristics shall match the stresses imposed by the circuit breaker rated momentary current.
- B. Minimum ratings:
 - 1. Nominal System Voltage: 13.2 kV 3-phase.
 - 2. Maximum Voltage: 15 kV rms.
 - 3. Frequency: 60 Hz.
 - 4. Insulation Level, 60 Hz: 36 kV, rms.
 - 5. Insulation Level, impulse: 95 kV, crest.
 - 6. Continuous Current: 1200 A.
 - 7. Short Circuit Current at Maximum Voltage: 25 kA rms.
 - 8. Fault Clearing Time: Five cycles max.

- C. Circuit Breaker Operating Mechanism:
1. Motor-charged and spring-operated unless otherwise approved by Engineer.
 2. Mechanism shall be designed to prevent overcharging.
 3. The mechanism shall ensure that the release of stored energy for closing the circuit breaker main contacts is prevented unless the mechanism has been fully charged.
 4. The stored-energy closing mechanism shall automatically charge itself within 15 seconds after closing of the breaker.
 5. Energy storage shall be sufficient for an open-close-open cycle at maximum rated short circuit current.
 6. Provide manual cranking capability to permit spring charging in the event motor power is unavailable. Provide one manual crank at each switchgear location.
 7. Provide manual trip and close buttons on front of circuit breaker.
 8. Withdrawal of circuit breaker from enclosure:
 - a. Provide an interlock to prevent withdrawal when the mechanism is fully charged.
 - b. Alternately, provide automatic controlled discharge of the stored energy when the circuit breaker is withdrawn from or inserted into the enclosure.
 9. Circuit breaker shall be electrically and mechanically trip free. The operating mechanism shall be non-pumping.
 10. Operation counter: Four-digit, non-resettable, register-type mechanical operations counter. Provide on each circuit breaker to record each close/open cycle.
- D. Circuit Breaker Control Voltage:
1. Control voltage: 125 Vdc.
 2. Closing mechanism voltage range: Plus or minus 15 percent of the nominal dc control voltage.
 3. Tripping mechanism voltage range: Plus or minus 25 percent of the nominal dc control voltage.
- E. Circuit Breaker Control Switches:
1. Open/Close: Switch located on breaker HMI and SAS HMI touch screen (see Section 34 21 31, Substation Automation System (SAS)).
 2. SAS HMI control switch shall permit open and close operations when the circuit breaker is in the connected position.
 3. Breaker HMI control switch shall permit open and close operations when the circuit breaker is in the test position.
 4. Provide a switch for resetting the circuit breaker after a trip and provide a mechanical trip indication at the control switch.

- F. Auxiliary contacts:
1. Provide a minimum of six electrically separate sets of reversible auxiliary contacts, in addition to those required for the circuit breaker control circuit.
 2. Auxiliary contacts shall be operated by the breaker mechanism in both the "connected" and "test" positions.
 3. Spare auxiliary contacts shall be wired to the outgoing terminal blocks.
- G. Indicating LEDs:
1. Provide indicating LEDs on the front of the circuit breaker enclosure to indicate the state of the circuit breaker:
 - a. Closed breaker: Red LED.
 - b. Tripped or open breaker: Green LED.
 2. Provide an amber LED above each local/remote switch which shall be illuminated when switch is in local position.
 3. Provide a white LED indicating light on the front of the circuit breaker enclosure to indicate the stored-energy closing mechanism is charged.

2.8 PROTECTIVE RELAYS

- A. General Requirements:
1. Conform to the applicable sections of IEEE C37.90.
 2. Cases: Rustproof metal or high-impact plastic rectangular cases with test switches, panel-mount form factor.
 3. Contacts: Silver-to-silver non-welding.
 4. Non-IED Relays: Self-resetting with seal-in, hand-resetting targets indicating relay operation.
 5. Arrangement:
 - a. Devices including switches, relays, indicating lights and test plugs shall be conveniently accessible and easily visible.
 - b. The grouping shall be modular and place related functions in proximity.
 - c. Devices of the same general type shall be manufactured by the same company and shall be similarly arranged and mounted.
 6. Mounting:
 - a. Flush mounted, plumb and square with the lines of the panels and as recommended by the manufacturer, with wiring connections on the back of the relay.
 - b. Mount on hinged or removable panels and not on a fixed portion of the switchgear.
 7. Color: Match color of switchgear. See Section 34 21 06, TES Common Work Results for Metals for color.

- B. Provide the following protective and monitoring devices at a minimum, as shown in the Contract Drawings. Additional protective devices recommended by Contractor or equipment manufacturers may be installed with Engineer approval.
- C. Ac Protective Relay - Intelligent Electronic Device (IED):
1. For each medium-voltage ac breaker provide a multi-function protective relay IED and related transducers:
 - a. IED must capture real-time voltage and current for a triggered event with pre- and post-trigger sampling data useful for analyzing trip information, and store in non-volatile memory.
 - b. IED shall communicate with the SAS via protocol specified in Section 34 21 31, TES Substation Automation System (SAS).
 2. Provide the following functions, at minimum:
 - a. Ac undervoltage (ANSI Device 27):
 - 1) Primary function: Trip and annunciate when the ac input voltage drops to 80 percent of nominal voltage.
 - 2) Relay shall also trip and annunciate upon loss of voltage due to utility outage.
 - 3) Relay shall contain field adjustable time delay.
 - b. Phase sequence relay (ANSI Device 47):
 - 1) Three-phase voltage protective relay connected to provide open phase protection.
 - 2) This relay shall contain a field adjustable time delay.
 - c. Ac overvoltage (ANSI Device 59):
 - d. Phase fault time overcurrent (ANSI Device 50/51).
 - 1) Primary function shall be to provide overload and fault protection for loads served.
 - 2) Relay shall be designed to compile a composite time overcurrent characteristic curve which shall best match the normal and overload requirements of the load and to match the thermal and mechanical withstand of transformers.
 - 3) Relay shall provide for both instantaneous and time delay overcurrent protection.
 - e. Ground fault time overcurrent (ANSI Device 50N/51N):
 - 1) A residual instantaneous and time delay relay connected to provide sensitive ground fault detection.
 - 2) This relay shall be field adjustable.
 - f. Control/Position of ac breaker (ANSI Device 52).

- g. Reverse Power (Device 32):
 - 1) Provide in incoming feeder cubicle connecting to utility service switchgear.
 - 2) This device shall trip and lock-out associated circuit breaker when it detects a flow of power from substation back toward the utility.
 - h. Local/Remote control (Device 43)
 - 3. Device shall have chart recording features with PC software used for downloading and analyzing faults. Transient fault recording function shall capture analog and digital pre-fault and post-fault waveforms and data.
- D. Provide the following additional ac protective relay:
- 1. Lockout (Device 86H):
 - a. Provide on the ac circuit breaker compartment.
 - b. Reset switch handle:
 - 1) Heavy-duty switchboard type pistol-grip handle.
 - 2) Acceptable Manufacturer: Electroschalt or approved equal.
 - c. Provide indication of "lockout" and "normal" at the reset switch.
 - d. When the main ac circuit breaker is tripped by the lockout relay, the following sequence of events shall occur:
 - 1) Dc feeder circuit breakers shall be opened for TES substations.
 - 2) Ac breaker shall remain locked out until manually reset.
- E. Trip Circuit Monitors:
- 1. Provide a trip circuit monitor for monitoring the trip coil on each of the following:
 - a. Medium voltage ac circuit breaker.
 - b. Lockout relay.
 - 2. Indication and Operation:
 - a. Green LED that illuminates when the trip coil is energized and turns off when the coil is de-energized.
 - b. NO and NC Form C contacts for indication of a failed trip coil.
 - c. Red LED that illuminates upon failure of the trip coil.
 - d. 200 millisecond delay to allow for auxiliary contacts to transfer.
 - e. LEDs: Plug-in replaceable with a life of 100,000 hours; protected against reverse polarity by a diode.
 - f. Control Power: 125 Vdc.
 - g. Manufacturer: E-max RAW-1D or approved equal.

- F. Protective device coordination: Perform a coordination study for the ac system in accordance with Section 34 21 73, TES Studies.

2.9 INSTRUMENTS AND METERS

- A. Analog instruments and meters ANSI C39.1.
1. Provide analog switchboard type ammeter and voltmeter, with 250 degree scales, rated for use with corresponding transformer.
 2. Cases shall be dust proof and covered with a non-reflecting glass window.
 3. The accuracy of all indicating instruments shall be within 1 percent of full scale reading.
 4. Voltmeters and ammeters shall be rated for use with the corresponding transformer.
 5. Scales shall be of a suitable range, equal to the associated potential or current transformer primary rating.
 6. Provide incoming line phase selector switches for connection to the line transformers for the ammeter and voltmeter.

2.10 INSTRUMENT TRANSFORMERS

- A. Instrument transformers shall conform to IEEE C57.13, with the additional requirements indicated below.
- B. Current transformers:
1. Shall be capable of withstanding thermal and mechanical ratings of the circuit breaker.
 2. Molded-rubber or epoxy construction, wound-type or bushing-mounted.
 3. Wound-type current transformers:
 - a. Provide separate compartment isolated from the control panel and all other equipment.
 - b. Provide a mounting frame which bolts securely to the switchgear frame.
 - c. Full-wave impulse insulation level: 125 kV.
 - d. Secondary terminal blocks shall have covers with integral shorting bars and secondary wiring shall be run to readily identifiable terminal block points in the control compartment.
 - e. Terminal block points shall also have integral shorting bars for the current transformer leads.
 4. Bushing-type current transformers: Low-voltage, ring-core, high-accuracy type designed for secure mounting on the primary contact support bushings.

5. Accuracy: Relaying accuracy classification, under the burdens imposed by the specified devices.
- C. Potential transformers (PTs):
1. Drawout-type, molded-rubber or epoxy construction.
 2. Transformers shall have full-wave impulse insulation level of 125 kV.
 3. Primary and secondary circuits of potential transformers shall be fused by means of non-renewable cartridge-type fuses meeting requirements of IEEE C37.46.
 4. Grounding of trunion: Trunion or other conveyance mechanism on which drawout PTs are mounted shall be continuously grounded in the fully inserted position, while being withdrawn, and when in the fully withdrawn position.
 5. Grounding of PT: Primary of PT shall be grounded, as soon as the primary circuit is disconnected, while the PT is being withdrawn and in the fully withdrawn position.
 - a. Grounds shall be beryllium copper.
 - b. Provide a viewing window in the PT drawer for viewing grounds. Grounding in the fully withdrawn position shall be visible from the exterior of the switchgear, without removing panels or parts, by a person standing on the floor.
 6. Fuses:
 - a. Primary fuses shall be completely disconnected before a person can access the transformer or its high-voltage fuses.
 - b. Secondary circuit fuses shall be installed in the low-voltage circuits and shall be located to permit replacement when the switchgear is in operation.
 7. Rating: Adequate for the burden requirements of the accuracy classification and capable of carrying rated load continuously without excessive heating or damage.

2.11 SOURCE QUALITY CONTROL

- A. Factory Design Tests:
1. Tests shall consist of all Design Tests as specified in IEEE C37.20.2.
 2. Perform tests on the ac switchgear assembly and each component of the ac switchgear.
 3. The main ac circuit breaker test shall be performed in accordance with the design tests as described in IEEE C37.09.
- B. Factory Production Tests:
1. Ac Circuit Breaker: Prior to mounting inside ac switchgear, perform the following on each ac circuit breaker in accordance with IEEE C37.09:
 - a. Nameplate check.
 - b. Control and secondary wiring checks.

- c. Clearance and mechanical adjustment check tests.
 - d. Mechanical operation tests.
 - e. Timing tests.
 - f. Stored energy system tests.
 - g. Conductivity of the current path test.
 - h. Low-frequency withstand voltage tests on major insulation components.
 - i. Current transformer.
 - j. Resistors and coils.
2. Ac switchgear: Perform production tests as part of TES Substation Factory Acceptance Tests, as specified in Section 34 21 90, TES Testing.

2.12 MANUFACTURE

- A. Manufacture switchgear in accordance with the referenced ANSI and IEEE standards.

2.13 INSTALLATION

- A. Install switchgear in TES substation enclosure in accordance with manufacturer's installation instructions and NECA 430.

2.14 SURGE ARRESTERS

- A. Provide surge arresters in Service Switchgear.
- B. Connect the surge arrester ground terminals directly to the switchgear ground bus connected to the station grounding electrode.

2.15 TRANSFER TABLE

- A. Provide transfer table at each substation for removing and lowering PTs and draw-out fuse trunions.
- B. Table shall be capable of being raised and lowered hydraulically from floor to trunion levels.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install ac switchgear in accordance with Section 34 21 17, TES Substation Design and Assembly, and Contract Drawings.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

- A. The quantities of accepted work will be measured in the following units. All measurements will be plan measure except for authorized changes.
 1. Description: Lump Sum

4.2 PAYMENT

- A. Payment will be made at the respective unit or lump-sum price listed in the proposal and shall be full compensation for all labor, materials, and equipment necessary to complete the respective unit in place. There will be no separate measurement or payment for any item of work not specifically identified and listed in the proposal, and all such work shall be considered a subsidiary item with all costs pertaining thereto included in the prices for other items listed in the proposal. At the Engineer's option, partial payment may be made for any lump sum item listed in the proposal, providing that the Contractor is diligently and satisfactorily pursuing full completion of such partially complete item in accordance with the approved job progress schedule.

END OF SECTION

SECTION 34 21 16

TES SUBSTATION ENCLOSURES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Prefabricated enclosures for TES substations.
 - 2. HVAC for prefabricated enclosures.
 - 3. Testing of prefabricated enclosures.

1.2 RELATED SECTIONS

- A. SECTION 34 21 05 – Common Work Results for TES
- B. SECTION 34 21 06 – TES Common Work Results for Metals
- C. SECTION 34 21 08 – TES Dielectric Epoxy Flooring
- D. SECTION 34 21 17 – TES Substation Design and Assembly
- E. SECTION 34 21 31 – TES Substation Automation System (SAS)
- F. SECTION 34 21 80 – TES Spare Parts and Special Tools
- G. SECTION 34 21 90 – TES Testing
- H. SECTION 34 22 26 – TES Grounding and Bonding

1.3 DEFINITIONS

- A. Galvanneal: As defined in Section 34 21 06, TES Common Work Results for Metals.

1.4 REFERENCED STANDARDS

- A. Section incorporates by reference the latest revisions of the following documents:
- B. American Institute of Steel Construction (AISC)
 - 1. AISC 303, Code of Standard Practice for Steel Buildings and Bridges
 - 2. AISC 360, Specification for Structural Steel Buildings
- C. ASTM International (ASTM)
 - 1. ASTM A384/A384M, Standard Practice for Safeguarding Against Warpage and Distortion During Hot Dip Galvanizing of Steel Assemblies
 - 2. ASTM A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
 - 3. ASTM E136 , Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°C

- D. Institute of Electrical and Electronics Engineers (IEEE)
 - 1. IEEE 1653.2, Standard for Uncontrolled Traction Power Rectifiers for Substation Applications Up to 1500 V DC Nominal Output
 - 2. IEEE C37.20.1, Standard for Metal-Enclosed Low-Voltage Power Circuit Breaker Switchgear
- E. International Code Council (ICC)
 - 1. International Building Code
 - 2. International Mechanical Code
 - 3. International Energy Conservation Code
- F. National Electrical Manufacturers Association (NEMA)
 - 1. NEMA 250, Enclosures for Electrical Equipment (1000 Volts Maximum)
 - 2. NEMA ICS 6, Industrial Control and Systems: Enclosures
- G. National Fire Protection Association (NFPA)
 - 1. NFPA 70, National Electrical Code

1.5 SUBMITTALS

- A. Procedures: Section 01 33 00, Submittal Procedures.
- B. Product Data:
 - 1. Seam caulking.
 - 2. Thermal and acoustical insulation, including weather stripping.
 - 3. Entry doors, including material, construction, and sealing gasket material.
 - 4. Door hardware, including hinges, handles, locks, panic bars, and door closer.
 - 5. Exterior equipment access door hardware including latches, hinges, gaskets, and door stops.
 - 6. HVAC units.
 - 7. HVAC control unit and thermostat.
- C. Spare Parts:
 - 1. Submit a list of spare parts to be provided under this Section.
 - 2. Submit at the same time as product data.
 - 3. Provide part numbers for each part, including a detailed break-down of each spare part assembly and set, as defined in Section 34 21 80, TES Spare Parts and Special Tools.

- D. Shop Drawings:
1. Structural and architectural plans to scale including the following:
 - a. Plans, elevations, and sections, including HVAC, door frames and openings, equipment mounting, lifting and anchorage details, and lighting.
 2. Drawings for fabrication including the following:
 - a. Floor plan showing framing and floor plate; equipment outlines and weights; floor openings; and welds and bolted connections.
 - b. Wall plans including framing, posts, beams, and other structural members; welds and bolted connections; interior and exterior wall panel details including interlocking, assembly of wall panels, and caulking; and connection of wall panel to base showing required z-type channel and wall panel lapped over floor seam.
 - c. Roof plan showing framing; welds and bolted connections; roof panel details including interlocking and rain cap, assembly of roof panels, and caulking; details of roof penetrations and the means used to prevent ingress of water; and connection of roof to walls.
 - d. Details of construction of doors, frames, welds, bolted connections and the means used to prevent ingress of water;.
 - e. Penetrations for cable, conduit, ventilation, or other purposes.
 - f. Clear indication on each drawing of each type of material, including type of galvanized finish, if any; and dimensions, gauge or thickness.
 3. Enclosure equipment grounding details, including ground grid connections.
- E. Compliance Certificates: For enclosure materials and performance.
- F. Calculations:
1. Structural:
 - a. Design calculations for the enclosure including analysis calculations for equipment, roof, wind, and seismic loadings, and for any temporary supports, certified by a structural engineer registered in the State of Missouri.
 - b. Design calculations for anchorage and supports, certified by a Professional Engineer registered in the State of Missouri.
 2. HVAC:
 - a. Sizing of heating, ventilating, and air conditioning units, including tabulation of interior equipment heat gains, infiltration gains/losses, conductive gains/losses and solar gains, certified by a mechanical engineer registered in the State of Missouri.

- G. Testing:
 - 1. Submit test procedures that meet the requirements of Section 34 21 90, TES Testing for the following:
 - a. Factory Design Tests.
 - b. Factory Production Tests.
 - 2. Submit test reports that meet the requirements of Section 34 21 90, TES Testing for the following:
 - a. Factory Design Tests.
 - b. Factory Production Tests.
- H. Operations and Maintenance Data:
 - 1. Submit manufacturer's operating and maintenance instructions on products specified in this Section, including the following requirements:
 - a. Repair procedure for powder coat finish.
 - 2. Submit immediately after approval of product data.

1.6 SPARE PARTS

- A. Provide spare parts in accordance with Section 34 21 80, TES Spare Parts and Special Tools.
- B. List below applies to items in this Specification Section.
 - 1. Lock cylinders: Keyed for TES substation doors; provide 4 spare.
 - 2. Padlocks: Keyed for TES substation equipment access doors: Provide 6 spare.

1.7 QUALITY ASSURANCE

- A. Comply with the requirements of the Project Quality Plan.
- B. Qualifications:
 - 1. Manufacturer of the pre-fabricated metal buildings shall be a company regularly engaged in the production of pre-fabricated galvanized steel buildings with a powder coat finish, and as approved by Engineer.
 - a. Manufacturer shall have constructed at least 50 similar buildings in the last 10 years.
 - b. Manufacturer shall be experienced in forming galvanized conforming to ASTM A653/A653M with minimum coating weight A25.
 - c. Once a manufacturer is approved, it shall not be discharged or otherwise replaced by the Contractor without the written approval of Engineer.
 - d. Personnel working on metal buildings shall be experienced, skilled, and familiar with building construction, including installing air conditioning, heating and ventilation systems.

2. Where engineering calculations are called out, they shall be performed by a professional engineer registered in the State of Missouri.
3. Welding shall be performed by Certified Welders. Refer to Section 34 21 06, TES Common Work Results for Metals, for detailed requirements.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. Each substation enclosure shall be a shop assembled, free-standing, self supporting, steel building, utilizing channel perimeter framework and rigidly braced with channel and angle cross members.
- B. Completed assembly shall be designed for shipment for installation at site.
- C. The enclosure shall be a totally integrated weatherproof unit that houses the indicated substation equipment. The enclosure shall provide a dry, vermin proof, condensation free, stable internal ambient temperature environment.

2.2 ENCLOSURE DESIGN

- A. Design enclosures and components for the service life specified in Section 34 21 17, TES Substation Design and Assembly.
- B. Design enclosure in accordance with AISC 303, AISC 360, International Building Code, and local building codes to withstand live roof loading, wind loading, and seismic loading based on the service conditions specified in Section 34 21 17, TES Substation Design and Assembly, and the stresses caused during loading, transportation, unloading and installation.
- C. Access to the substation equipment will be from the sides and the rear. Enclosure design must allow the removal of all major equipment from outside or inside of the substation enclosure without disassembly of the equipment.
- D. Design enclosure for securing to a reinforced concrete slab as indicated on the Contract Drawings.
- E. Ratings:
 1. Complete enclosure shall have a NEMA 250 Type 4 rating.
 2. Doors, removable panels, joints, walls, roofs, floors, vents, louvers and outdoor accessories shall be weatherproof under environmental conditions specified in 34 21 17, TES Substation Design and Assembly.
- F. Structural design engineering calculations and drawings shall be sealed by a professional engineer registered in the State of Missouri.

2.3 BASE

- A. Fabricate from welded structural steel beams, rigidly braced with steel cross members to provide adequate strength for lifting the complete assembly, including all equipment.
- B. Structural steel:
 1. Hot-dip galvanized before welding in accordance with Section 34 21 06, TES Common Work Results for Metals.

2. Avoid using structural steel members with nonsymmetrical sections to minimize warpage and distortion during hot-dip galvanizing, as recommended by ASTM A384/A384M.
- C. Welds:
1. Mask steel in weld areas before galvanizing in accordance with Section 34 21 06, TES Common Work Results for Metals.
 2. Touch up welds as required in Section 34 21 06, TES Common Work Results for Metals.

2.4 ENTRY STEP

- A. Provide a single step at each entry door welded or bolted to the base.
- B. Design:
1. Design such that water may not become trapped on or in the structure.
 2. Comply with the IBC and 29 CFR 1910.24.
 3. Include in structural design engineering calculations sealed by a professional engineer registered in the State of Missouri.
 4. If design includes bolted attachment, bolt heads must be on the interior and nuts on the exterior, with bolt heads tack welded on the interior so they cannot turn if tightening is required.
- C. Dimensions:
1. Step depth: Minimum 10 inches, measured from outer edge of door threshold.
 2. Step width: Width of door.
 3. Height: 7 inches below interior finished floor height, plus or minus 1/2 inch.
- D. Material:
1. Support structure: Steel.
 2. Step: Steel grating, non-skid.
- E. Finish:
1. Hot-dip galvanized after fabrication in accordance with Section 34 21 06, Common Work Results for Metals.
 2. If step is welded to base, mask steel in weld areas before galvanizing in accordance with Section 34 21 06, TES Common Work Results for Metals.
 3. Coat welds made after hot-dip galvanizing in accordance with Section 34 21 06, TES Common Work Results for Metals.

2.5 FLOOR

- A. Fabricate from steel plate stitch-welded to the base, with cutouts as indicated or required.
- B. Steel plate: Minimum 1/4 inch.

- C. The floor shall withstand the weight of the heaviest circuit breaker, rectifier transformer or other equipment item which may have to be moved along the floor, without significant deflection.
- D. Indicate in engineering calculations the piece of equipment that may be moved along the floor that was used for floor calculations.
- E. Cutouts:
 - 1. Provide access to cables or conduits that penetrate floors as indicated on Contract Drawings or as otherwise necessary.
 - 2. Provide insulated protection on edges for cable penetrations to prevent damage to cable insulation.
 - 3. Provide removable cover plates for openings:
 - a. Ac switchgear: 11 gage steel with stainless steel hardware to latch it in place.
 - b. Dc switchgear: 1/4-inch glastic with non-metallic hardware to latch it in place.
 - c. Other penetrations: 1/4-inch glastic with non-metallic hardware to latch it in place.

2.6 WALLS

- A. Exterior walls:
 - 1. Material: Sheet steel panels, of a grade to be determined by Contractors structural design engineer.
 - 2. Coating:
 - a. Galvanneal meeting the requirements of ASTM A653/A653M with minimum coating weight A25.
 - b. Galvanneal shall not be quenched by the steel manufacturer or galvanizer or chemically treated in a way that inhibits powder coating.
 - 3. Thickness:
 - a. Minimum 11-gauge.
 - b. The specified minimum thickness shall apply to the base metal only.
 - 4. Interlock adjoining panels with J-type interlocking, as indicated in Figure 1, below.
 - 5. Seal seams with manufacturer recommended caulking.

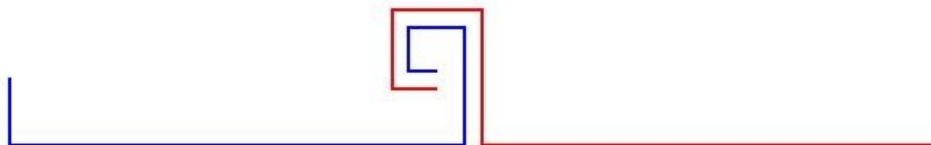


Figure 1: Cross Section Wall Panels J-Type Interlocking

6. At wall-panel base, provide Z-type channel and lap exterior wall panel over the floor seam to prevent drain back, as illustrated in Figure 2, below.

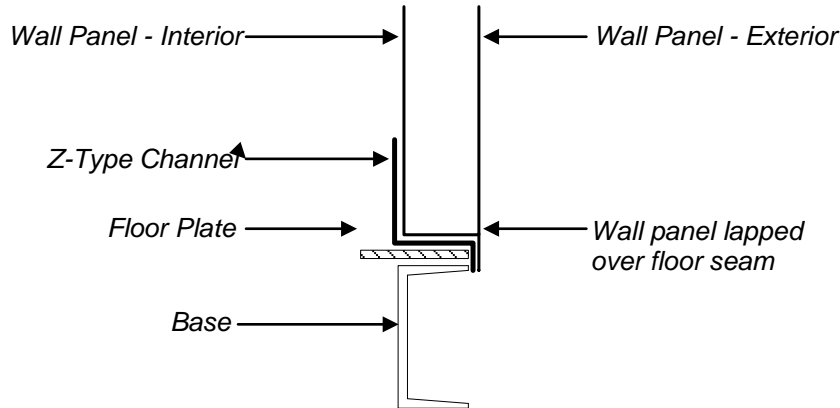


Figure 2: Cross Section Wall-Panel Base Z-Type Channel

- B. Interior walls:
 1. Material: Same as exterior walls, above.
 2. Coating: Same as exterior walls, above.
 3. Thickness:
 - a. Minimum 14-gauge.
 - b. The specified minimum thickness shall apply to the base metal only.

2.7 ROOF

- A. Shed type, with pitch as shown on Contract Drawings, fabricated from interlocking sheet steel panels.
 1. Material: Same as exterior walls, above.
 2. Coating: Same as exterior walls, above.
 3. Thickness: Same as exterior walls, above.
 4. Interlocking: J-type, with standing seams and rain caps over seams, as indicated in Figure 3, below.
 5. Seal seams with manufacturer recommended caulking.

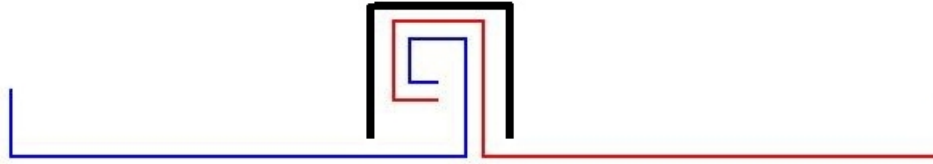


Figure 3: Cross Section Roof Panels Standing Seams With Rain Cap

- B. Roof penetrations:
1. Shall be used only with approval of the Engineer.
 2. If used, shall be minimal, with each flashed and waterproofed.
- C. Gutters and Downspouts:
1. Material: Same as exterior walls, above.
 2. Coating: Same as exterior walls, above.
 3. Thickness: Same as exterior walls, above.
 4. Gutters: Provide one on each long side of the enclosure
 5. Down spouts:
 - a. Provide one at each end of each gutter, a pair for each gutter.
 - b. Design: Angle at the bottom and extend far enough from enclosure to divert water minimum 12 inches beyond foundation slab.

2.8 THERMAL AND ACOUSTICAL INSULATION

- A. General Requirements:
1. Insulating materials shall have a certified classification of "non combustible" as defined by ASTM E136.
 2. Flame proofing of insulating materials will not be acceptable. Proof of certification shall be by one of the following:
 - a. UL label or listing.
 - b. National Bureau of Standards test results.
 - c. Certified test report from a nationally recognized testing laboratory.
- B. Thermal Insulation:
1. Enclosure thermal insulation shall comply with International Energy Conservation Code.
 2. Floor: Solid insulating panels.

- C. Acoustical insulation: Provide where needed to control continuous sound levels outside substations.

2.9 ENTRY DOORS

- A. Provide a minimum of two entry doors, located as indicated on the Contract Drawings.
- B. Material: Minimum 14 gauge sheet steel, galvanized in accordance with ASTM A653/A653 with minimum coating weight A40.
- C. Insulation: R value in accordance with applicable energy code.
- D. Size: Not smaller than shown on Contract Drawings.
- E. Door Hardware:
 - 1. Hinges: Stainless steel with stainless steel hinge pins.
 - 2. Panic hardware: One or three point crash-bar safety latches to permit opening doors from within under all conditions.
 - 3. Door Handles: Shaped such that they are easy to grasp with one hand and do not require tight grasping, pinching, or twisting of the wrist to operate. Door knobs are not acceptable.
 - 4. Locks: Self-locking, tamper proof, integrated with entry handles.
 - a. Locks all keyed alike.
 - b. Owner to provide keying requirements.
 - c. Provide two keys for each substation enclosure.
 - 5. Door Closer:
 - a. Heavy duty, highly corrosion resistant; all external body components of aluminum, zinc alloy or stainless steel material with stainless-steel fasteners.
 - b. Shall close door firmly and have hold-open position.
- F. Sealing:
 - 1. Doors shall be tightly sealed with neoprene gaskets.
 - 2. Secure seals to the doors so as to allow easy replacement.
 - 3. Design of doors shall prevent intrusion of water around the seams.

2.10 EXTERIOR EQUIPMENT ACCESS DOORS

- A. Provide hinged doors where shown on Contract Drawings:
 - 1. Equipment doors shall allow access to the rear of the ac switchgear, rectifier transformer, rectifier, and dc switchgear from the outside of the substation for regular maintenance.
 - 2. Opening the rectifier transformer rear double doors shall allow removal of the transformer as a unit from the outside of the substation.

- B. Material: Minimum 11 gauge sheet steel, galvanized in accordance with ASTM A653/A653M with minimum coating weight A25.
- C. Provide stiffening members as required.
- D. The exterior equipment access doors shall meet or exceed the requirements of NEMA ICS 6 for weatherproof NEMA 250 Type 4 enclosures.
- E. Latches:
 - 1. Three-point, padlockable, heavy-duty stainless steel switchgear type.
 - 2. Handle shall be located at working height referenced to actual final grade elevation at site.
- F. Hinges:
 - 1. Stainless steel, with stainless steel hinge pins and hardware.
 - 2. Provide a minimum of three concealed hinges.
- G. Door gaskets: Neoprene. Secure seals to doors to allow easy replacement.
- H. Door stop: Provide one for each door to hold it in the open position
- I. Padlock: Provide one padlock complying with Section 34 21 05, Common Work Results for TES, for each external door.

2.11 GROUNDING PADS

- A. Provide four copper grounding pads, bonded to the steel base of the enclosure at the corners as indicated on the Contract Drawings, for connection of 2-hole cable lugs.
 - 1. Grounding pads shall be on the interior of the base.
 - 2. Coordinate location of ground pads with location of access holes and adjust location of ground pads on switchgear side of the enclosure, if necessary, to make them accessible.
- B. Provide openings in floor for access, with removable cover plates as described above in Article titled " Floor."
 - 1. Size: Minimum 10 inches x 12 inches.
 - 2. Location: Coordinate access openings with equipment layout such that no part of the minimum size opening will be obstructed by the equipment. Openings in equipment provided for cable entrance may also be used for access to grounding pads.
- C. Connect enclosure grounding pads to enclosure interior perimeter ground specified in Section 34 22 26, TES Grounding and Bonding.

2.12 HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

- A. Interior Environment: Provide thermostatically controlled HVAC system to prevent condensation and maintain the interior temperature between 65 degrees F and 77 degrees F under all operating conditions.

- B. General Requirements:
1. HVAC system shall comply with the International Mechanical Code.
 2. HVAC units shall be controlled by the same thermostat and control unit.
 3. High Temperature Alarm:
 - a. If substation interior temperature reaches 85 degrees F send alarm to SAS. See Section 34 21 31, TES Substation Automation System (SAS).
 - b. Alarm temperature set point shall be field adjustable.
 4. Supply voltage: Either 120 Vac or 208/240 Vac, single-phase.
 5. Finish color: Match finish color of substation enclosure.
 6. HVAC Units: Unitary, packaged, wall-mounted type, hermetically-sealed compressors, UL listed, AHRI performance certified, with economizer cycle, meeting minimum efficiency requirements of the International Energy Conservation Code.
- C. Ventilation and Air Conditioning: Design system for heat gain in the substation under the following simultaneous conditions.
1. Maximum loading of the rectifier transformer per IEEE 1653.2 for Heavy Duty Traction Service.
 2. Exterior design conditions per International Energy Conservation Code.
 3. Maximum solar heat gain.
- D. Ventilation system shall provide sufficient air changes during heating periods to prevent battery-evolved hydrogen gases from exceeding a 1 percent concentration level.
- E. Heating: Design based on conduction and infiltration heat loss with exterior design conditions per International Energy Conservation Code and substation de-energized (no heat gain from interior equipment).
- F. Air Intakes:
1. Grill: Provide over filter to prevent entrance of foreign objects.
 2. Filters: Provide micro-glass, high-efficiency disposable filters in filter frames.
 3. Exterior: Provide tamper-proof hardware for filters located on exterior of enclosure.
- G. Provide two HVAC units for each substation enclosure with each unit capable of maintaining the interior environment specified above.
- H. Economizer Cycle Cooling:
1. Provide HVAC units in conjunction with an exhaust fan to allow cooling using only exterior air when that air is less than 60 degrees F.
 2. Equip inlet and exhaust ducts for economizer cooling with gasketed, motorized dampers to seal the enclosure when economizer cooling is not possible.

3. Economizer design shall maintain zero or slightly positive pressure within the substation enclosure at maximum ventilation rate.
- I. Redundant Operation:
 1. HVAC units shall operate with one unit on standby.
 2. Failure of the operating unit shall cause the other unit to commence operation automatically.
 3. Provide controls to manually and automatically alternate the units to minimize wear on each unit.

2.13 FINISHES

- A. Exterior metal surfaces:
 1. Roof and walls: Powder coat in accordance with Section 34 21 06, TES Common Work Results for Metals.
 2. Gutters and downspouts: Powder coat in accordance with Section 34 21 06, TES Common Work Results for Metals.
 3. Floor bottom and support structure: Shop-applied paint coating system in accordance with Section 34 21 06, TES Common Work Results for Metals.
 4. Color: See Section 34 21 06, TES Common Work Results for Metals.
- B. Interior metal walls and ceiling:
 1. Powder coat in accordance with Section 34 21 06, TES Common Work Results for Metals.
 2. Color: See Section 34 21 06, TES Common Work Results for Metals.
- C. Interior floor surfaces:
 1. Shop-applied paint coating system in accordance with Section 34 21 06, TES Common Work Results for Metals.
 2. Dielectric epoxy floor, where indicated on Contract Drawings, in accordance with Section 34 21 08, TES Dielectric Epoxy Flooring.
 3. Floor shall have a non-skid finish.
 4. Color: Shop-applied paint coating system shall match color of dielectric epoxy flooring. See Section 34 21 08, TES Dielectric Epoxy Flooring.

2.14 SOURCE QUALITY CONTROL

- A. Factory Design Tests:
 1. Coating qualification test: Perform in accordance with IEEE C37.20.1.
- B. Factory Production Tests:
 1. Rain test for outdoor LV switchgear:
 - a. Perform on each substation in accordance with IEEE C37.20.1. An existing design test will not be accepted; this test will not be waived.

- b. In addition to IEEE C37.20.1 requirements, address HVAC systems as follows:
 - 1) Test first with HVAC systems installed but not operating.
 - 2) If HVAC systems have louvered openings that open when the system is in operation, retest with all such openings in the fully open position.
- c. Replace IEEE C37.20.1 satisfaction of test requirements with the following: the enclosure shall have satisfactorily met the requirements of this test if during the visible inspection no water is found.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Installation of HVAC units after substation delivery shall comply with the following:
 - 1. International Mechanical Code.
 - 2. NFPA 70.
- B. Provide condensate drain pipe for HVAC units.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

- A. The quantities of accepted work will be measured in the following units. All measurements will be plan measure except for authorized changes.
 - 1. Description: Lump Sum

4.2 PAYMENT

- A. Payment will be made at the respective unit or lump-sum price listed in the proposal and shall be full compensation for all labor, materials, and equipment necessary to complete the respective unit in place. There will be no separate measurement or payment for any item of work not specifically identified and listed in the proposal, and all such work shall be considered a subsidiary item with all costs pertaining thereto included in the prices for other items listed in the proposal. At the Engineer's option, partial payment may be made for any lump sum item listed in the proposal, providing that the Contractor is diligently and satisfactorily pursuing full completion of such partially complete item in accordance with the approved job progress schedule.

END OF SECTION

SECTION 34 21 17**TES SUBSTATION DESIGN AND ASSEMBLY****PART 1 - GENERAL****1.1 SUMMARY**

- A. This Section includes the following
 - 1. Designing and assembling prefabricated TES substations.
 - 2. Designing and installing a field erected TES substation in the vehicle maintenance facility (VMF).
 - 3. Miscellaneous materials, equipment, and components including but not limited to wiring devices and cover plates, smoke detector, blue light, Knox box, mobile work station, fire extinguisher, relays, switches, pushbuttons, indicating lights, terminal blocks, ac and dc breaker test stations, ETS buttons and enclosures, corrosion control junction box, communications rack, electrical insulating materials, signage and identification materials.
 - 4. Software to upload and download settings for intelligent electronic devices (IEDs).

1.2 RELATED SECTIONS

- A. SECTION 34 21 05 – Common Work Results for TES
- B. SECTION 34 21 08 – TES Dielectric Epoxy Flooring
- C. SECTION 34 21 14 – TES Medium-Voltage Ac Circuit-Breaker Switchgear
- D. SECTION 34 21 18 – TES Lighting
- E. SECTION 34 21 19 – TES Dc Switchgear
- F. SECTION 34 21 31 – TES Substation Automation System (SAS)
- G. SECTION 34 21 70 – VMF TES Control and APS
- H. SECTION 34 21 80 – TES Spare Parts and Special Tools
- I. SECTION 34 22 05 – TES Common Work Results for Conductors and Cable
- J. SECTION 34 22 33 – TES Raceway and Boxes

1.3 DEFINITIONS

- A. Intelligent Electronic Device (IED): Refers to any digital or numerical-based protection, metering, control, or monitoring device that has processing, recording and reporting capabilities and a local human machine interface (HMI).

1.4 REFERENCED STANDARDS

- A. Section incorporates by reference the latest revisions of the following documents:

- B. American National Standards Institute (ANSI)
 - 1. ANSI Z535.2, Environmental Facility and Safety Signs
- C. Code of Federal Regulations (CFR)
 - 1. 29 CFR 1926.200, Accident Prevention Signs and Tags
 - 2. 47 CFR Part 15, Radio Frequency Devices
- D. Federal Transit Administration (FTA)
 - 1. FTA QA/QC Guidelines FTA-IT-90-5001-02.1.
- E. Institute of Electrical and Electronics Engineers (IEEE)
 - 1. IEEE C37.90, Standard for Relays and Relay Systems Associated with Electric Power Apparatus
 - 2. IEEE C37.90.2, Standard for Withstand Capability of Relay Systems to Radiated Electromagnetic Interference from Transceivers
- F. International Organization of Standards (ISO)
 - 1. Quality Management Systems - Fundamentals and Vocabulary - ISO 9000
 - 2. Quality Management Systems - Requirements - ISO 9001
- G. National Electrical Contractors Association (NECA)
 - 1. NECA 1, Standard Practice of Good Workmanship in Electrical Construction
- H. National Electrical Manufacturers Association (NEMA)
 - 1. NEMA 250, Enclosures for Electrical Equipment (1000 Volts Maximum)
 - 2. NEMA WD 1, General Requirements for Wiring Devices
 - 3. NEMA WD 5, Specific-Purpose Wiring Devices
- I. National Fire Protection Association (NFPA)
 - 1. NFPA 70, National Electrical Code (NEC)

1.5 SUBMITTALS

- A. Procedures: Section 01 33 00, Submittal Procedures.
- B. Product Data: Submit manufacturer's product data for products specified in this Section if not submitted under another Section:
 - 1. Wiring devices.
 - 2. Cover plates.
 - 3. Smoke detectors.
 - 4. Exterior blue light.
 - 5. Knox box.

6. Mobile work station.
 7. Fire extinguisher.
 8. Relays.
 9. Switches.
 10. Pushbuttons.
 11. Indicating lights.
 12. Terminal blocks.
 13. Ac and dc breaker test stations.
 14. ETS buttons and enclosures.
 15. Corrosion control junction box.
 16. Communications rack.
 17. Electrical insulating laminate.
 18. Identification:
 - a. Baked porcelain enameled steel signs,
 - b. Vinyl signs,
 - c. Conduit identification labels,
 - d. Nameplates.
- C. Samples:
1. "While in use" wet or damp location cover.
 2. Each type of identification product
- D. Identification Schedule: Submit a schedule of proposed nameplates and labels, including material, size, color, text, and location, before ordering.
- E. Submit a request for permission to perform a Field Evaluation for equipment that is not labeled or listed.
- F. Shop Drawings:
1. Comply with Owner's drafting standards.
 2. Drawing Scale:
 - a. Use only standard architectural or engineering scale. Non-standard scales, such as 15 inches equals 1 foot, will not be accepted.
 - b. Drawings must be properly converted to pdf format such that scalability is maintained.
 3. Provide each of the drawing types listed below for TES substations.
 4. One-line Diagrams: Provide for each substation.

5. Three-line Diagrams: Provide for each substation.
6. Schematic Diagrams:
 - a. Format by subsystem, using identical device symbols and wire designators for each subsystem.
 - b. Clearly delineate interfaces, from page to page and subsystem to subsystem.
 - c. These drawings shall include at least the following information:
 - 1) Wire connections, terminations and identification.
 - 2) Nominal voltages, equipment and equipment ratings, currents, frequencies, significant resistance values, and the rating of all loads.
 - 3) All low voltage dc control circuits.
 - 4) Schematic location (page number, for example) of the energization portion of each device (such as the coil in a relay) noted adjacent to the operating portions (such as relay interlocks) of the device.
7. Wiring diagrams: Provide a set for each substation:
 - a. Show all wiring, raceways, conduits, and connections.
 - b. Provide equipment connection, intra-cubicle, and inter-cubicle wiring diagrams.
 - c. Connection diagrams: Show the internal wiring and terminal block arrangement within each piece of equipment and identify each outgoing power and control connection and wire.
 - d. Interconnection diagrams: Show wiring from the equipment terminal blocks, to external equipment connections, terminal blocks, and devices.
 - e. Show nominal voltages, equipment and equipment ratings, currents, frequencies, significant resistance values, and the rating of all loads.
 - f. Label devices identical to the actual device and show their locations on panels.
 - g. Each terminal block and device shall have its own unique numbers and letters for identification.
 - h. As a minimum, provide the following information for each wire segment:
 - 1) Wire code (schematic designation).
 - 2) Origin (FROM device and terminal).
 - 3) Destination (TO device and terminal).
 - 4) Wire size.
8. Substation Equipment and Raceway Drawings: Show actual equipment to be provided and raceways, with all drawn to scale.

-
9. Panel schedules: Submit for each panel to be provided.
 10. Equipment arrangement drawings:
 - a. Show actual equipment to be provided and details of installation, drawn to scale, using layout provided in Contract Drawings.
 - b. Alternate substation equipment layouts may be proposed by Contractor, subject to Engineer's approval.
 - c. Provide the following drawings:
 - 1) Certified substation footprint with locations of openings for incoming and outgoing feeders within 45 days of NTP.
 - 2) Substation plans and elevations showing the equipment layout, including equipment numbers, locations, and dimensions.
 - 3) Equipment front elevations and wall elevations showing the location of each piece of equipment and dimensions.
 - 4) Installation and mounting details for all equipment, including installation of the transformer enclosure partitions, method of anchorage for each piece of equipment, and method for providing electrical isolation for the dc switchgear.
 - 5) Raceway layout plans showing cable trays, conduits, including numbers, locations, and dimensions.
 11. Signage drawings to scale with text:
 - a. Exterior substation number designation and location.
 - b. Warning signs and locations.
 - c. Interior manufacturer's identification and location, if any.
- G. Substation ANSI Device Table:
1. Provide a set of device tables for substation ANSI devices in a single section in the schematic book.
 2. Arrange the table in a logical fashion by system device type.
 3. Provide data for all system and subsystem components including, but not limited to the following:
 - a. Electrical control and power components (groups, panels, pc cards, contactors, relays, circuit breakers, capacitors, inductors, resistors, specialized modules, rectifiers, diodes, fuses and other components, as appropriate).
 - b. Electrical equipment (rectifiers, transformers, switchgear, substation automation system (SAS), interface terminal board, and the like).
 4. Include the following data:
 - a. Equipment and associated number where a device is located.
 - b. Elementary schematic drawing number where the device appears.

-
- c. A brief description of the device.
 - d. Manufacturer's model or style number.
 - e. Manufacturer's name and type number of the device.
 - f. Device rating.
 - g. Number, rating, and types of contacts on device, if applicable.
 - h. Remarks on any other relevant features of the device.
- H. Bill of Materials (BOM): Provide the following in spreadsheet format:
- 1. Contract number.
 - 2. Supplier number.
 - 3. Column for Owner's stores number.
 - 4. Other data required for procurement of materials used in the construction of all parts of the electrification system.
 - 5. Cross-reference between related drawings and the BOMs.
 - 6. Generic description or specification.
 - 7. Brand name, where applicable.
 - 8. Manufacturer's part number.
 - 9. Original manufacturer or supplier, including address, telephone number, e-mail address, FAX number, and contact person.
 - 10. Notation on parts that are custom manufactured only upon request.
- I. Software:
- 1. Provide interface and configuration software for uploading settings to and downloading event history from intelligent electronic device (IED).
 - 2. Include software license for Owner.
- J. Operations and Maintenance Materials:
- 1. Submit manufacturer's operating and maintenance instructions on products specified in this Section.
 - 2. Submit immediately after approval of product data.
- K. Substation History Books:
- 1. The substation "history book" shall contain a complete record for each substation, shall be kept up to date throughout the manufacturing process, and may be inspected by the Engineer at any time.
 - 2. Format:
 - a. Furnish a table of contents at the front of the book indicating the page number for each type of information included.

- b. Separate major sections with tabs.
- c. Furnish with consecutive numbering on each page.
3. Provide a history book for each substation, with the following information at a minimum:
 - a. Copy of approved plan review, if plan review is required by state law or city ordinance.
 - b. Factory production test reports.
 - c. Description and completion dates of substation modifications, and a list of modifications pending with expected completion dates.
 - d. A record of abnormalities that occur during the manufacture of the substation or its subsystems, including their authorized repair procedures.
 - e. List of substation defects that were identified by the Contractor's QA or the Engineer during assembly, commissioning, and testing, and the disposition of each as verified by inspection.
 - f. List of serial-numbered apparatus.
 - g. Shipping documents.
 - h. Field acceptance test reports.
 - i. Integrated testing reports.
 - j. Final relay settings.
 - k. Copy of final rail voltage monitoring and grounding system settings.
 - l. Copy of permit signed off by the issuing department.
 - m. Open items status list.
4. Changes in recorded data that are made during performance of the Contract shall be clearly identified and justified to the satisfaction of the Engineer.

1.6 SPARE PARTS

- A. Provide spare parts in accordance with Section 34 21 80, TES Spare Parts and Special Tools.
- B. List below applies to items in this Specification Section.
 1. Blue light: Provide 2 spare.

1.7 QUALITY ASSURANCE

- A. Comply with the requirements of the Project Quality Plan.

- B. Quality Assurance (QA) Requirements for TES Substation Manufacturer:
1. Assign a QA Manager responsible for managing and with authority for acting on all quality matters relate to TES substation manufacture and assembly, and who has the following qualifications:
 - a. Minimum 5 years overall quality experience.
 - b. Minimum 2 years prior experience as a QA Manager, on transit project(s) of comparable complexity to this Contract.
 - c. Minimum 2 years as a Quality Control (QC) Manager or Supervisor, Quality Engineer, Quality Auditor or QC Inspector.
 2. Quality Plan:
 - a. Submit a Quality Plan that addresses the 15 quality elements identified in FTA QA/QC Guidelines FTA-IT-90-5001-02.1.
 - b. Provide descriptions of, and references to Quality procedures and work instructions, including specified requirements unique to this Contract, that relate to quality system elements defined in Quality Management Systems - Fundamentals and Vocabulary ISO 9000 and Quality Management Systems - Requirements ISO 9001.
 - c. Include the following elements in the Quality Plan:
 - 1) QA/QC Organization and staff, including job description and an organizational chart showing relationship between Contractor's General Manager, Project Manager, Quality Manager, Subcontractors, and consultants.
 - 2) Documented Quality System.
 - 3) Design Control.
 - 4) Document Control and Submittal Management.
 - 5) Subcontractor, Consultant and Supplier Control.
 - 6) Identification, Traceability and Receiving, Handling, Storage and Control of Products, Materials and Equipment.
 - 7) Process Control and control of special fabrication processes, e.g. welding and powder coating.
 - 8) Inspection and Testing.
 - 9) Control of measuring and test equipment.
 - 10) Inspection and Test Reporting.
 - 11) Identification, Control and Correction of Non-conforming Conditions.
 - 12) Corrective Actions.
 - 13) Quality Records.
 - 14) Training.

- 15) Configuration control for software.
- 16) Change control for factory drawings, fabrications, assembly, wiring, testing, and as-built drawings.

C. Qualifications:

1. Electrical work at TES substation manufacturer's plant shall be performed by electrical workers skilled in the installation of electrical equipment and knowledgeable in the requirements of NFPA 70 and NECA 1, as certified by manufacturer's Quality Plan.

D. Performance Requirements:

1. Each component, subassembly and assembly provided for TES substations shall be of a proven design with a history of at least 5 years successful operation at the time of Contract award in similar railroad or rail transit service.
2. Use off-the-shelf service-proven equipment and hardware approved by the Engineer.
3. TES Substation Expected Service Life: 50 years in continuous service, 24 hours a day, 365 days a year.

E. Listed and Labeled Equipment and Material:

1. Provide wherever standards for these products have been established.
2. Materials that are not listed or labeled require approval by Engineer before use.
3. Products that have not been tested or certified for the use intended shall not be used when equivalent listed or labeled materials are available.
4. The label or listing will be acceptable as sufficient evidence that the materials and equipment do conform to the specified standards.
5. Electrical equipment and material not listed or labeled shall be furnished with a Field Evaluation label provided by an approved Testing Laboratory, and certifying that the equipment conforms to the requirements of UL and ANSI.
 - a. This product evaluation may be performed in the factory or on-site as approved by Engineer.
 - b. A request for permission to perform a Field Evaluation in the factory or onsite shall be submitted to Engineer for approval.

F. TES Substation Systemic Failure:

1. Monitor substation component failures during the commissioning, testing, and warranty phase.
2. Systemic Failure: Failure of 10 percent or more of the same components used for the same function during this time period.
3. Within 30 days of receiving notification of systemic failure, begin a program to repair or replace all components of the type involved in the systemic failure.
4. Develop the repair or replacement for the components to remedy the nature and probable cause of the component failure.

5. Submit proposed repair or replacement to the Engineer for approval.
6. Components shall be replaced at no cost to the Owner.

1.8 WARRANTY

- A. Provide an extended warranty for unproven equipment.
- B. Unproven equipment means equipment that meets any one of the criteria described below:
 1. Equipment that is not service proven in the rail transit industry in the United States. To be service proven equipment shall have been in use for a minimum of five years.
 2. Equipment or assemblies that have not been used before by this manufacturer in the rail transit industry in the United States.
 3. Equipment or assemblies that use software developed from the ground up for this project.

PART 2 - PRODUCTS

2.1 TES SUBSTATION DESIGN

- A. General:
 1. Design prefabricated and built-in-place substations that comply with the requirements of the Contract Documents.
 2. Submit product data, shop drawings, and samples, as specified, for Engineer approval before starting procurement or manufacturing.
 3. The proposed substation equipment must fit within the space as shown in Contract Drawings.
- B. Prefabricated Substations:
 1. Furnish shop drawings that show the layout of every aspect of prefabricated substation such that each substation built from the shop drawings is identical to the others in every respect.
 2. Substations shall have identical electrical equipment, traction power equipment, and appurtenances; and identical layout of equipment, appurtenances, raceways, wiring, terminal blocks and wiring connections.
 3. Equipment shall be fully interchangeable without modification.
 4. Changes made to the design after manufacturing has started must be documented and implemented in every substation.
- C. Built-in-Place VMF Substation:
 1. Furnish shop drawings that show the layout of every aspect of VMF substation, including size and location of building systems and appurtenances, locations of each wiring device, and layout of substation equipment and raceways.
 2. The VMF substation shall be identical to prefabricated substations to the extent possible.

3. Coordinate final design and layout of VMF building systems and appurtenances in TES substation room with approved substation equipment, including the following:
 - a. Coordinate location of wiring devices, fire protection system components, and other wall-mounted equipment with location of wall-mounted electrical insulating laminate and substation equipment.
 - b. Ac Feeds from Building Electrical Room:
 - 1) Coordinate with approved final equipment layouts.
 - 2) Include TES substation in building electrical coordination study.
 - c. HVAC: Coordinate design of building HVAC system to accommodate the layout and heat output of approved substation equipment.
 - d. Lighting: Lay out and install building lighting system to coordinate with layout of substation equipment and provide lighting levels required in Section 34 21 18, TES Lighting.
 - e. Fire Protection System: The substation room must be a separate zone in the building fire alarm system. Provide alarm contact to operate lockout trip relay, ANSI Device 86 upon detection of smoke based only on that zone.
- D. Maintainability: Conveniently locate devices requiring regular calibration, resetting or operation within easy reach of personnel.
- E. Noise Compliance: Design substation to comply with applicable noise regulations with substation equipment operating at rated full load capacity, and sound measured from outside substation on all sides.
- F. Radio Frequency Interference:
 1. Design substation equipment, protective relays meters, instruments and devices to minimize the radio frequency generated in accordance with 47 CFR Part 15.
 2. Design substation equipment, protective relays, meters, instruments and devices such that they are immune to misoperations caused by ambient radio frequency signals, in accordance with IEEE C37.90.2.
- G. Design Conference:
 1. TES substation design conference will be held at substation manufacturer's facility within 60 days after NTP. Substation design personnel and a representative of the Contractor are required to attend. The following will be discussed:
 - a. Basic substation layouts.
 - b. One-line diagram.
 - c. Proposed basic substation parts.
 - d. Proposed sequence of substation work.
 - e. Design, production and field testing procedures.
 - f. Submittal list.

2.2 TES SUBSTATION DESCRIPTION AND DESIGN CRITERIA

- A. Prefabricated TES Substation General Parameters:
1. Provide complete factory assembled TES substation in weatherproof enclosure.
 2. Substation rating: 350 KW, heavy traction service.
 3. Substations will be unattended.
 4. Dc System Voltage:
 - a. 750 Vdc at rated load.
 - b. Maximum Voltage with Regeneration: 900 Vdc.
 - c. Regulation: 4.5 percent between 1 percent and 200 percent load.
- B. VMF TES Substation General Parameters:
1. Provide field assembled TES substation in VMF
 2. Substation rating: 150 kW, heavy traction service.
 3. Substations will be unattended.
 4. Dc System Voltage:
 - a. 750 Vdc at rated load.
 - b. Maximum Voltage with Regeneration: 900 Vdc
 - c. Regulation: 4.5 percent between 1 percent and 200 percent load.
- C. Environmental Requirements: Provide substation suitable for operation without impairments at its standard ratings throughout the range of worst values listed below:
1. Ambient Outdoor Temperature: Minus 25 degrees F to 115 degrees F.
 2. Maximum Ambient Outdoor Humidity: 100 percent.
 3. Design Wind Speed: 110 mph.
 4. Accumulated Snow: 30 inches.
 5. Accumulated Ice: 3 inches.
 6. Seismic: Comply with Section 34 21 05, Common Work Results for TES.
 7. Altitude: 1,026 feet above sea level.
- D. Utility Data: Power to the TES substations will be supplied from Kansas City Power & Light (KCP&L) at 13.2 kV. Other required utility data may be obtained from KCP&L.

2.3 UTILITY METERING

- A. Utility Metering Section: See Section 34 21 14, TES Medium-Voltage Ac Circuit-Breaker Switchgear.
- B. Meter base: Furnished by KCP&L.

2.4 WIRING DEVICES AND COVER PLATES

- A. General Requirements:
1. Type: NEMA WD 1, heavy-duty general-use type.
 2. Color: Grey, or as selected by Engineer.
 3. Wiring: Back or side wired.
 4. Terminals: Screw type or combination screw-clamp type.
 5. Terminal screws: No. 8 or larger, captive or terminal type.
- B. Switches:
1. Tumbler-type toggle switches that operate in any position.
 2. Voltage rating: 120-277 Vac.
 3. Fully enclosed with entire body and cover of molded phenolic, urea, or melamine. Do not use fiber, paper, or similar flammable insulating material for body or cover.
 4. Mounting yoke: Metal with plaster ears, insulated from the mechanism and fastened to the switch body by bolts, screws, rivets, or other substantial means.
 5. Switch contacts: Silver or silver alloy.
 6. Applications:
 - a. Lighting: Fully-rated 20 A at 120 V or 277 V.
 - b. Straight resistance loads: May be snap switches as specified in this Section, of the proper rating up to 30 A at 120-277 V.
 7. Testing: Capable of withstanding tests as outlined in NEMA WD 1. If requested by Engineer, submit evidence that the types of switches proposed have satisfactorily withstood these tests.
- C. Convenience Receptacles:
1. Bodies and Bases: Fire-resistant, nonabsorptive, hot-molded phenolic.
 2. Plaster ears: Metal, integral with supporting member.
 3. Configuration: 20R, single- or duplex-type as indicated.
 4. Contacts: Double-grip bronze type with spring steel backup clips so that both sides of each male prong of the plug will be in firm contact. Applies also to grounding contact.
- D. Locking-blade Receptacles: NEMA WD 5.
- E. GFCI Receptacles: Duplex receptacles, 120 V, 60 Hz, 20 A with built-in test, reset buttons, and ground fault tripped indication.
1. Trip: Interrupt the circuit within 1/30 second on a 5 milliampere earth leakage current.

2. Use GFCIs designed for end of run installation or with provisions for feeding through to protect other outlets on the circuit.
- F. Cover Plates:
1. Interior cover:
 - a. Device covers: Raised, galvanized steel.
 - b. Provide multi-gang plates where required. Segmented cover plates are not acceptable.
 2. Exterior and wet or damp location cover:
 - a. NEC-compliant "while-in-use" cover.
 - b. Heavy-duty, die-cast aluminum, powder coated.
 - c. Listed for wet locations, rated NEMA 250 Type 3R, with neoprene gasket.
 - d. Padlockable.
 - e. Depth: Minimum 3-1/4 inches.
 - f. Submit sample for approval.

2.5 SMOKE DETECTORS

- A. Ionization photoelectric type.
- B. Plug-in unit with mounting plate hard wired.
- C. Integrally self-monitoring, self-diagnostic, with visual trouble indication.
- D. Designed to reduce false alarms from dust, insects, radio frequency interference (RFI), and external light.

2.6 EXTERIOR BLUE LIGHT

- A. LED blue color light, 360 degrees illumination, suitable for wet locations.
- B. Light shall incorporate a failsafe circuit with an annunciator indicating failure of the LED, power supply, or fuse.
- C. Approved Manufacturer/Product: Federal Signal LED Pulsator 212650-3, or approved equal.

2.7 KNOX BOX WITH LOCK

- A. 6 inches by 6 inches by 4 inches.

2.8 MOBILE WORKSTATION

- A. Construction:
 1. Heavy-duty structural foam.
 2. Capacity: 750 pounds.

- B. Features:
 - 1. Wheels: Four 5-inch casters.
 - 2. Drawers: Four, with ball bearing door slides.
 - 3. Cabinet with adjustable shelf.
 - 4. Built-in drawer lock.
- C. Nominal Dimensions:
 - 1. Width: 49 inches.
 - 2. Depth: 26 inches.
 - 3. Height: Nominal 38 inches.
- D. Approved Manufacturer/Product: Rubbermaid TradeMaster, Model 4533-88 or approved equal.

2.9 FIRE EXTINGUISHER

- A. CO2, 20 pound.
- B. Portable, appropriate for equipment provided.

2.10 CIRCUIT BREAKERS AND DISCONNECT SWITCHES

- A. Provide breakers and switches with auxiliary contacts where position indications from circuit breakers or disconnect switches are required.
- B. Auxiliary relays are not acceptable to monitor position indication of circuit breakers or disconnect switches.

2.11 RELAYS

- A. Drop-out Voltage: 80 V.
- B. Contacts:
 - 1. Current rating: Based on continuous, inrush, or interrupting requirements for the duty category, whichever is most stringent, and then derated by at least a factor of four.
 - 2. Voltage rating: Contacts shall be rated for a minimum of twice the applied voltage.
 - 3. Select materials for the actual loads and not solely on the device rating. Silver bifurcated contacts and gold alloy bifurcated cross-bar contacts are preferred on low level and dry circuits, respectively.
- C. Coils:
 - 1. Coils of all devices shall be suppressed, except where performance may be affected.
 - 2. Unsuppressed coils are permitted only with written approval of the Engineer.
- D. Service Life: Relays shall have a guaranteed mechanical service life of at least 50 years.

- E. Protective relays: IEEE C37.90, utility grade, immune from inadvertent operation due to ambient EMI, including radio frequency signals.
- F. Auxiliary and control relays:
 - 1. Heavy duty, UL listed.
 - 2. Mechanical durability: Minimum 50,000 cycles.
 - 3. Electrical durability: Minimum 100,000 cycles for resistive load.

2.12 SWITCHES

- A. Control Switches: Selector switch type, heavy duty rated, with metal operator.
- B. Position Switches (Device 33): Roller-plunger type switch, rated heavy or medium duty, brass or steel plunger, metallic enclosure, rated for 20,000 operations, minimum.
- C. Cubicle Lighting Door Switches: Roller-plunger type switch, rated heavy or medium duty, brass or steel plunger, metallic enclosure, voltage and current rating suitable for approved luminaires, rated for 20,000 operations, minimum.
- D. Cubicle Lighting External Switches: Panel-mount rocker type; rated heavy or medium duty; voltage and current rating suitable for approved luminaires; rated for 20,000 operations, minimum; "on" and "off" positions indicated on the switch by "1" and "0".
- E. Intrusion Detection Door Switches: Magnetic, rated heavy or medium duty, metallic case, screw mounted.

2.13 PUSHBUTTONS

- A. Heavy duty, 600 V, 30 mm size,
- B. Momentary contact or latching, as indicated or as appropriate for design.

2.14 INDICATING LIGHTS

- A. Long-life, high-brightness using LED arrays and integral current limiting resistors.
- B. Indicators shall be selected to permit maximum visibility in direct sunlight from all viewing angles.

2.15 TERMINAL BLOCKS

- A. Heavy-duty molded nylon, DIN rail mounted, 600 V, minimum current rating equal to overcurrent protective device, spring-loaded captive screws with pressure plates,
- B. Acceptable Manufacturer/ Product: GE CR151K Series or approved equal.

2.16 AC AND DC BREAKER TEST STATIONS

- A. Ac: Capable of tripping ac breaker.
- B. Dc: Capable of tripping dc breaker.
- C. Umbilical cord:
 - 1. For connecting to breaker.
 - 2. Provide strain relief where cord connects to cabinet.

3. Provide means to conveniently stow umbilical cord when not in use.

2.17 EMERGENCY TRIP STATIONS (ETS)

- A. ETS Buttons:
 1. Heavy duty, industrial grade, pushbutton operator and contact block, rated for the load, minimum 2-inch diameter mushroom head, red.
 2. TES Substations: Momentary contact.
 3. VMF Shop: See Section 34 21 70, VMF TES Control and APS.
- B. Protective cover: Provide cover or shield to prevent inadvertent activation. Engineer will determine whether proposed protective cover is suitable for the intended purpose.
- C. Enclosure:
 1. Substation Interior: NEMA 250, Type 1.
 2. Substation Exterior: NEMA 250 Type 4X, stainless steel, gasketed, hinged, lockable. Provide padlock complying with Section 34 21 05, Common Work Results for TES.

2.18 CORROSION CONTROL JUNCTION BOX

- A. Box:
 1. Hinged cover electrical cabinet complying with Section 34 22 33, TES Raceway and Boxes.
 2. Size box to allow easy access for testing.
- B. Test Jacks: Panel-mount with recessed closed entry design.
 1. Body material: Nylon.
 2. Color:
 - a. Negative bus: Black
 - b. Earth ground: Green
 3. Contact Material: Beryllium copper silver plate.
 4. Size: Accepts 0.080 tip.
 5. Terminal: Brass, tin plated.
 6. Current rating: 10 A.
 7. Breakdown Voltage: 5700 A
 8. Acceptable Manufacturer/ Product: Keystone Electronics, fully insulated panel mount test jacks, deluxe.
- C. Labeling: Comply with Article below titled "Identification."
 1. Provide "Corrosion Control Junction Box" nameplate on cabinet.

2. Provide "Negative Bus" and "Earth Ground" labels under test jacks according to colors, above.

2.19 COMMUNICATIONS RACK

- A. Steel, fully enclosed, 19 inch, with adjustable front and rear rackmount rails, and removable side panels.
- B. Wall-mountable, with hinged wall bracket that allows cabinet to swing out from wall.
- C. Height: 18 U
- D. Front Door: Ventilated, removable, with means for locking.
- E. Side Panels: Ventilated, removable, locking.
- F. Capacity: 250 lbs.
- G. Provide 1 U horizontal cable manager.
- H. Provide grounding lug.
- I. Acceptable Manufacturer/Product: Tripp Lite Smartrack Series, SRW18US, or approved equal.

2.20 ELECTRICAL INSULATING MATERIALS

- A. Wherever "electrical insulating laminates", "laminates" or "glastic barrier" are called out in the Contract Documents, use the following:
 1. Acceptable Manufacturer/Product: Roehling Glastic Composites, Glastic 1494, or approved equal.
 2. Thickness: 1/4 inch.
- B. Electrically Insulated Floor Covering: Specified in Section 34 21 08, TES Dielectric Epoxy Flooring.
- C. Prohibited insulating materials.
 1. Electrical insulating paper, also called "fish paper".
 2. Electrical tape of any type.

2.21 MISCELLANEOUS PRODUCTS

- A. Cable ties: See Section 34 22 05, TES Common Work Results for Systems Conductors and Cable.
- B. Metallic fasteners: See Section 34 21 05, Common Work Results for TES.

2.22 SOFTWARE

- A. Provide interface and configuration software for uploading settings to and downloading event history from intelligent electronic device (IED).
- B. Provide software that will work with each type of IED provided under a Division 34 specification section.
- C. Software shall work on a standard laptop with Microsoft Windows 7 operating system.

2.23 SIGNAGE

- A. Substation Number Sign: Provide on two sides of the enclosure in location approved by Engineer.
1. Sign material: Baked porcelain enameled steel, with the porcelain enamel forming a complete ceramic envelope around the steel plate.
 2. Color: Black lettering on a white background, or as directed by Engineer.
 3. Number designation: "TES Substation - XX," where "XX" is a number that will be provided by the Engineer.
 4. Lettering height: 6 inches, minimum.
 5. Location: As approved by Engineer.
 6. Attachment hardware: Stainless steel.
- B. Warning Signs:
1. Material:
 - a. Exterior locations: Baked porcelain enameled steel (see above under "Substation Number Sign.")
 - b. Interior locations: 3.5 mil adhesive backed vinyl film with digital or screen-printed images.
 2. Color: Compliant with 29 CFR 1926.200 and ANSI Z535.2.
 3. Text:
 - a. Substation Entry doors: "DANGER; HIGH VOLTAGE" and "DO NOT ENTER."
 - b. Substation Exterior equipment access doors: "DANGER: LIVE PARTS" and "DANGER HIGH VOLTAGE."
 - c. Substation Cubicles with 750 V or above: "DANGER: LIVE PARTS" and "DANGER HIGH VOLTAGE."
 - d. Locations where there are live parts after ac main breaker is opened: Submit language appropriate to the specific location for approval.
 4. Location:
 - a. Substation Entry doors: Exterior of door.
 - b. Substation Exterior equipment access doors: Exterior of door and front of removable panel inside exterior door, if any.
 - c. Substation Cubicles with 750 V or above: Front, rear, and side access doors.
- C. Manufacturer's Name: Shall not be placed on the exterior of the enclosure. It will be allowed on the interior of the enclosure but shall be approved by the Engineer.

2.24 IDENTIFICATION

- A. Equipment Identification
1. Provide a number for each piece of equipment such as switchgear sections and circuit breakers, and for devices such as relays, control switches, LED indications, meters, relays, and displays.
 - a. Prefix: TES substation number, as indicated on Contract Drawings.
 - b. Suffix: Indicates the type of equipment or device.
 2. Use the Owner's numbering scheme on submitted Contractor drawings and submittals.
 3. Place the Owner's part number on as-built drawings.
 4. Engineer will furnish numbering standard.
- B. Wire and Cable:
1. Develop an identification scheme for wires and cables for use on Contractor drawings.
 2. For wire sleeve and cable tag requirements, see Section 34 22 05, TES Common Work Results for Conductors and Cable.
- C. Conduit Identification Labels: Laminated, machine-printed labels with high-strength adhesive, black letters on yellow background.
1. 2-inch and smaller conduits: Nominal 3/4-inch wide
 2. 2-1/2-inch and larger conduits: Nominal 1-inch wide labels.
 3. Approved Manufacturer/Product: Brother TZ-series tape, or approved equal.
 4. Use label printer compatible with chosen tape.
- D. Nameplates:
1. Engraved three-layer melamine laminated plastic, not less than 3/32-inch thick. Provide nameplates with black letters on a white background unless otherwise noted.
 2. Equipment nameplates: 1-5/8 inches high with 7/8-inch high characters minimum.
 3. Device nameplates: 7/8-inch high and have 1/4-inch high characters.
 4. Other equipment nameplates shall be sized and lettered according to the equipment and application as approved by the Engineer.
- E. Permanently identify equipment with engraved metal labels containing the following:
1. Supplier's name.
 2. Part number.
 3. Revision level.

- F. Serial Numbers:
1. Assign discrete serial numbers in sequential, numerical order for the total quantity of each component, including spares.
 2. Serial numbers are subject to the Engineer's approval.
 3. Duplicate serial numbers shall not be used within the type or model.
 4. Present to the Engineer as each portion of the installation is completed or when spare components are received.
 5. Track serial number transfers and prepare a list of all serial-numbered apparatus installed in each substation for inclusion in the substation history book.
 6. At a minimum, the following equipment shall have serial numbers applied:
 - a. Ac main breaker.
 - b. Rectifier transformer.
 - c. Rectifier assemblies.
 - d. Interphase transformers.
 - e. Dc feeder breakers.
 - f. Auxiliary power transformer.
 - g. Substation alarm panel HMI.
 - h. Motors within equipment.
 - i. Electronic cards.
 - j. Enclosures.
 - k. Manually-operated disconnect switches.
- G. Identification Schedule: Submit a proposed schedule of nameplates and labels including material, size, color, text, and location, before ordering.

2.25 FACTORY ASSEMBLY

- A. General Requirements:
1. Provide products in accordance with product listings, manufacturer's recommendations, relevant codes and regulations, and standard industry practice for electrical installations.
 2. Provide electrical materials, equipment, appurtenances, and accessories in locations as indicated and in accordance with NECA 1.
 3. Provide supporting members, fastenings, framing, hangers, bracing, brackets, straps, bolts, and angles as required to set and connect the Work rigidly.
 4. Control erection tolerance requirements so as to not impair the strength, safety, serviceability, or appearance of the installations.

-
5. Complete installation: Contract Drawings show electrical equipment diagrammatically and do not show all accessories or fittings that may be required. Provide complete and operable electrical systems and installations in conformance with these Specifications.
- B. Anchoring and Support:
1. Do not weld electrical materials for attachment or support.
 2. Provide anchor bolts and anchorage items as required to comply with Contractor's seismic design.
- C. Installation of Wiring:
1. Provide wiring systems complete as indicated and required for proper service.
 2. Provide ample slack wire for motor loops, service connections, and extensions.
- D. Installation of Utility Metering:
1. Install KCP&L-furnished meter socket on exterior of substation enclosure per KCP&L requirements.
 2. Provide conduit to meter socket and wire per KCP&L requirements.
- E. Installation of Wiring Devices and Cover Plates:
1. Install switches, receptacles, special purpose outlets, and cover plates complete in accordance with NECA 1, NFPA 70, and local electrical codes.
 2. Locate wiring devices at heights in accordance with NECA 1, except as otherwise indicated.
 3. Provide GFCI duplex receptacles on the interior and exterior of prefabricated substation enclosures and where indicated.
 4. Provide a cover plate for each switch, receptacle, and special purpose outlet.
 5. Exterior and damp locations:
 - a. Provide cast metal outlet boxes with threaded hubs as specified in Section 34 22 33, TES Raceway and Boxes.
 - b. Provide with weatherproof cover plate, as specified above.
- F. Installation of Smoke Detectors:
1. Operation: Provide alarm contact to operate lockout trip relay, ANSI Device 86 upon detection of smoke.
 2. Location: Provide at strategic locations to detect smoke or products of combustion such that operation of the circuit breakers will not activate smoke detection system.
- G. Installation of Exterior Blue Light: Blue Light shall illuminate for alarms indicated in Section 34 21 31, Substation Automation System (SAS).
- H. Installation of Knox Box:
1. Provide two on the exterior of each substation as indicated on Contract Drawings.

2. Obtain keying requirements from Kansas City Fire Department.
3. Provide substation key in each Knox box.
- I. Installation of Mobile Workstation: Provide one in each substation.
- J. Installation of Fire Extinguisher:
 1. Provide two per substation.
 2. Mount to the inside wall of the substation enclosure near each entry door.
- K. Installation of Relays:
 1. Wire Terminations: Terminate a maximum of two wires on relay or contactor terminals.
 2. Orientation: Mount and orient relays and contactors as recommended by the supplier or manufacturer.
- L. Installation of Switches:
 1. Provide position switches (Device 33) at the following door locations to trip and lock out the ac main breaker and annunciate the opening of a door:
 - a. Top and bottom of the rectifier interior enclosure doors.
 - b. Top and bottom of the transformer interior enclosure doors.
 - c. Top of positive and negative disconnect switch interior enclosure doors.
 - d. Top of each exterior equipment door that does not provide access to live parts after the ac main breaker is opened.
 - e. Separate control compartments do not require Device 33.
 2. Provide position switches (Device 33) at the following door locations to annunciate the opening of a door, only, without tripping the ac main breaker:
 - a. Top of each exterior equipment door where there is the possibility of access to live parts even after the ac main breaker is opened, such as from utility power or dc power backfeeding from another substation.
 - b. In these locations, provide a glastic barrier inside the exterior door to protect personnel, and attach a warning sign to the glastic cautioning against the specific threat.
 3. Provide position switches (Device 33) at the following locations to indicate switch position:
 - a. Positive switch.
 - b. Negative switch.
 4. Cubicle Lighting Door Switches: Provide a door switch to switch cubicle lighting for each cubicle with interior cubicle lighting, as specified in Section 34 21 18 TES Lighting.

-
5. Cubicle Lighting External Switches: Provide an external switch wired in parallel with the door switch at each location where the lighted cubicle has a viewing window.
 6. Intrusion Detection Door Switches:
 - a. Provide at each entry door and at each exterior equipment access door.
 - b. Wire on two separate zones as follows:
 - 1) Zone One: Entry doors.
 - 2) Zone Two: Exterior equipment access doors.
- M. Installation of Pushbuttons: Provide where indicated or as required.
- N. Installation of Indicating Lights:
1. Position Indication:
 - a. Breaker Closed: Illuminated red light.
 - b. Breaker Open: Illuminated green light.
 - c. Lockout relay normal position: Illuminated red light.
 - d. Lockout relay tripped: Illuminated green light.
 2. Indicating lights: LEDs used on the switchgear sections shall be of the same manufacturer and model.
- O. Installation of Terminal Blocks:
1. Provide wherever there is a wiring connection or splice within switchgear or other electrical equipment.
 2. No other type of splice may be used within switchgear or other electrical equipment.
- P. Installation of Ac and Dc Breaker Test Stations:
1. Provide one ac and one dc wall mounted unit per substation.
 2. Install each test station in close proximity to circuit breakers to be tested.
- Q. Installation of Substation Emergency Trip Stations:
1. Provide four for each substation, two on the interior of each TES substation enclosure next to each entrance and two on the exterior, as shown on Contract Drawings.
 2. Wire emergency trip station pushbuttons in a loop circuit of series wired contacts that energize a summary relay.
 3. Interruption of the series circuit shall cause the substation to shut down by:
 - a. Tripping and locking out the main ac breaker.
 - b. Tripping and locking out all dc feeder breakers.

4. Depressing the exterior emergency trip pushbutton shall cause transfer tripping of the adjacent substations.
 5. See Section 34 21 19, TES Dc Switchgear, for additional transfer trip requirements.
- R. Installation of Corrosion Control Junction Box:
1. Provide in each TES substation.
 2. Locate such that access does not require shutting down substation.
 3. Connect test jacks to dc negative bus and earth ground:
- S. Installation of Communications Rack: Provide one in each TES substation in location indicated on Contract Drawings.
- T. Installation of Insulating Materials:
1. Insulate the following with electrical insulating laminate:
 - a. Walls:
 - 1) If the clearance between the dc switchgear and wall is less than 6 feet, cover wall to full height.
 - 2) Exception: Omit electrical insulating laminate on inside surfaces of rear equipment access doors.
 - b. HVAC ducts: Cover all parts of duct with clearance from dc switchgear less than 6 feet.
 - c. Between rectifier transformer and rectifier:
 - 1) Provide a continuous piece of laminate to isolate the rectifier transformer from the rectifier, as indicated on Contract Drawings.
 - 2) Extend full height barrier into the room far enough to make it physically impossible for a person to touch both the rectifier transformer and the dc equipment at the same time.
 - 3) Reinforce edge with a non-metallic angle or channel fastened to the floor and ceiling for stiffness.
 - d. Between rectifier and negative cubicle.
 - e. Between negative cubicle and dc feeder breakers.
 - f. Metallic surfaces:
 - 1) Within 6 feet of rectifier or dc switchgear.
 - 2) For metallic surfaces not suitable for electrical insulating laminates, such as curved surfaces, provide an alternate, such as sheet rubber or an insulated shield over the surface.
 - g. Arc chutes: Provide a continuous piece of laminate on the ceiling over arc chutes of dc breakers if conductive surfaces are within 3 feet of top of dc switchgear.

2. Fasteners: Secure laminate in place using non-metallic, non-conductive fasteners, in accordance with manufacturer's instructions.
- U. Installation in Vicinity of Rectifier and Dc Distribution Equipment:
1. Within 6 feet of dc rectifier, dc switchgear, and dc distribution equipment, provide non-metallic raceways, boxes, covers, equipment, and supports.
 2. Alternatively, provide substantial insulating barriers to prevent simultaneous contact with dc equipment enclosures and adjacent metal surfaces.
- V. Installation of Cable Ties (tie wraps):
1. Secure cable tie mounting blocks with a screw.
 2. Adhesive type mounting blocks shall not be used unless secured with a screw.
- W. Installation of Dissimilar Material Connections:
1. Not permitted at electrical connections or connections requiring disassembly for maintenance or for removal and replacement of equipment.
 2. Not permitted except at permanent connections.
 3. Provide suitable electrochemical isolation.
 4. Isolation treatments shall be permanent and not require maintenance or replacement for the life of the equipment or installation.
- X. Torque bolted connections in accordance with Section 34 21 05, Common Work Results for TES.
- Y. Installation of Equipment Identification:
1. Provide nameplates for equipment specified in 34 21 xx Sections.
 2. Provide a nameplate with a unique number for each piece of equipment such as switchboard sections, panelboards, circuit breakers, and devices.
 3. Where multiple devices are enclosed in one cubicle, section, or enclosure, provide a nameplate for each individual device, located on the interior or exterior of the cubicle, section, or enclosure, as approved by Engineer.
 4. Where locations of nameplates cannot be adequately described in the identification schedule specified above in the Part 2 Article titled "Identification", provide shop drawings showing the location of each label.
 5. Obtain approval for material, size, color, text, and location of nameplates and labels before installing.
 6. Fasten nameplates to the equipment or device enclosure door with stainless steel machine screws.

PART 3 - EXECUTION

3.1 FIELD INSTALLATION

- A. Requirements of Article, above, titled "Factory Assembly" apply to field installation.

- B. Seal equipment enclosures against dust, whenever dusty conditions are present inside the rooms or outside, during the construction period.
- C. Provide seismic anchorage and bracing in accordance with seismic design and calculations submitted under Section 34 21 05, Common Work Results for TES.

3.2 BUILT-IN-PLACE VMF SUBSTATION

- A. Floor: Install dielectric floor in accordance with Section 34 21 08, TES Dielectric Epoxy Flooring.
- B. Lighting: Install lighting in accordance with Section 34 21 18, TES Lighting.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

- A. The quantities of accepted work will be measured in the following units. All measurements will be plan measure except for authorized changes.
 - 1. Description: Lump Sum

4.2 PAYMENT

- A. Payment will be made at the respective unit or lump-sum price listed in the proposal and shall be full compensation for all labor, materials, and equipment necessary to complete the respective unit in place. There will be no separate measurement or payment for any item of work not specifically identified and listed in the proposal, and all such work shall be considered a subsidiary item with all costs pertaining thereto included in the prices for other items listed in the proposal. At the Engineer's option, partial payment may be made for any lump sum item listed in the proposal, providing that the Contractor is diligently and satisfactorily pursuing full completion of such partially complete item in accordance with the approved job progress schedule.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 34 21 18**TES LIGHTING****PART 1 - GENERAL****1.1 SUMMARY**

- A. This Section includes the following:
 - 1. Interior substation overhead and emergency lighting.
 - 2. Exterior substation lighting.
 - 3. Lighting inside equipment enclosures.

1.2 RELATED SECTIONS

- A. SECTION 34 21 17 – TES Substation Design and Assembly
- B. SECTION 34 21 25 – TES Dc Control Power

1.3 REFERENCED STANDARDS

- A. Section incorporates by reference the latest revisions of the following documents:
- B. Institute of Electrical and Electronics Engineers (IEEE)
 - 1. IEEE C62.41, Guide on Surge Voltages in AC Power Circuits Rated up to 600V
- C. National Fire Protection Association (NFPA)
 - 1. NFPA 70, National Electrical Code
- D. Underwriters Laboratories Inc. (UL)
 - 1. UL 1570, Fluorescent Lighting Fixtures

1.4 SUBMITTALS

- A. Procedures: Section 01 33 00, Submittal Procedures.
- B. Product Data:
 - 1. Document that proposed luminaires, ballast and lamps fully comply with Contract Documents.
 - 2. Indicate luminaire construction, photometric performance, installation, and maintenance requirements.
 - 3. Include clear and legible product specifications, drawings and illustrations of sufficient detail to describe the following:
 - a. Luminaire housing, hardware, and finishes.
 - b. Light controlling elements.

- c. Electrical components, including lampholders, ballast, and provision for conduit entry.
 - d. Support details. Indicate weight of luminaire, complete with lamps.
 4. Include procedures for installation of the complete lighting unit in its final service location.
- C. Shop Drawings: Lighting layout with proposed luminaires indicated by manufacturer and model number.
- D. Calculations: Show that specified lighting levels are achieved with proposed luminaires.
- E. Operations and Maintenance Data:
 1. Submit manufacturer's operating and maintenance instructions on products specified in this Section, including the following:
 - a. Materials and components clearly indicated in the parts list.
 - b. Relamping methods.
 - c. Special tools required.
 - d. Frequency of inspection, tightening, or other service recommended for preventative maintenance.
 2. Submit immediately after approval of product data.

PART 2 - PRODUCTS

2.1 PERFORMANCE CRITERIA

- A. Each substation shall have interior and exterior lighting to provide the specified minimum light levels.
- B. Minimum Lighting Levels:
 1. Interior: 70 footcandles at 30 inches horizontal above the aisle floor.
 2. Exterior: 2 footcandles, measured at ground level.
 3. Emergency Lighting: Minimum 2 footcandles at floor level.
 4. Minimum lighting levels shall be maintained throughout the substation. Average lighting level shall not be used to meet this requirement.

2.2 COMPONENTS

- A. Ballasts:
 1. Mount ballast securely inside luminaire to obtain the necessary heat dissipation.
 2. Ballasts for fluorescent lamps shall match the characteristics of the lamps, and have the following characteristics:
 - a. Operate lamps at a frequency of 20 kHz or higher without visible flicker.

- b. Listed Class P.
 - c. Total Harmonic Distortion: Less than 10 percent at 277 V.
 - d. Current crest factor: Less than 1.5.
 - e. Power factor: 0.98 minimum.
 - f. Audible noise rating: Class A or better.
 - g. Contain no Polychlorinated Biphenyls (PCBs).
 - h. Transient protection: IEEE C62.41, Category A.
 - i. Inherent thermal protection.
 - j. Provide constant light output with input voltage fluctuation of plus or minus 5 percent.
 - k. Provide instant-start for parallel wiring connection of lamps. Allow remaining lamps to maintain full output, in the event of lamp failure on multiple lamp luminaire.
 - l. Provide reliable lamp starting at 50 degrees F for interior luminaires and 0 degrees F for exterior luminaires.
- B. Lamps:
- 1. Provide lamps used in the illumination system of standard manufacture, readily available, and of the highest efficiency and life consistent with other requirements of the illumination system.
 - 2. Ensure all lamps of each type are provided by a single manufacturer.
 - 3. Fluorescent Lamps:
 - a. Energy-efficient T8, rapid-start fluorescent lamp rated 265 mA.
 - b. Life: Ensure lamps have a rated minimum average life of 20,000 hours.
 - c. Color Temperature: Minimum 3500 degrees K Correlated Color Temperature (CCT).
 - d. Color Rendering Index (CRI): Minimum 78.
 - e. Environmental: Use lamps for T8 fluorescent lighting that have reduced mercury contents that meet U.S. Environmental Protection Agency (EPA) Toxic Characteristic Leaching Procedure (TCLP) test for nonhazardous fluorescent light waste.
- C. Reflector Material: Prefinished, copper-free aluminum alloy, minimum thickness 0.032 inch, Architectural Type 1 with Class M1 anodic coating providing 83 percent reflectivity.

2.3 LUMINAIRES

- A. Interior of Substation Enclosure
- 1. Ceiling mounted, industrial fluorescent luminaire with clear, prismatic diffuser complying with UL 1570.

2. Acrylic lens: Manufactured from virgin-acrylic extrusion or injection molding pellets.
- B. Exterior of Substation Enclosure:
1. Wall-mounted, vandal-resistant, LED luminaire, full cut-off type.
 2. UL listed for 40 degrees C. maximum ambient and wet locations with IP66 ingress rating. Luminaire shall comply with IES LM-79 and LM-80 and be DLC (Design Lights Consortium) qualified.
 3. Housing: Die-cast aluminum, with a hinged door secured by captive stainless steel, tamper-resistant screw. Housing shall incorporate cooling fins specifically design for cooling LED light source and driver. Approximate dimensions of complete luminaire: 6"Wx7"Hx4"D including back-box. Provide with wire guard.
 4. Finish: Epoxy or polyester powder-coat paint, white.
 5. Optical: Sealed LED compartment with anodized, mirror-finish, forward-throw reflector, high-output bright-white (5000K CCT) LED, impact resistant tempered glass lens and silicone sealing gaskets. Luminaire shall deliver at least 1400 lumens, be rated full-cutoff with BUG rating B1-U0-G0 or better, and be suitable for wall-mounting 8 feet or greater above surrounding surface.
 6. Electrical: Integrated electronic LED driver with integral surge protection shall be mounted to housing for effective cooling. Provide luminaires with integral photocontrol or a single NEMA-style, aimable photocontrol wired in luminaire circuit.
 7. Acceptable Product: Lumark XTOR2A-WT-WG or approved equal.
- C. Emergency Lighting:
1. Self contained units containing lamps, battery, battery charger, controls, test switch, and status indicator.
 2. Lighting Heads: High-output 4.5 W LED MR16 lighting heads; minimum two lamps per unit.
 3. Battery:
 - a. Nickel-cadmium, 12 V, rechargeable, sealed, maintenance-free.
 - b. Capacity: Shall supply rated lamp load for 1-1/2 hours, minimum.
 - c. Life expectancy: 10 years.
 4. Battery charger:
 - a. Solid-state, current-limited, temperature-compensated, short-circuit proof, and reverse-polarity protected with plus-or-minus 1 percent regulation.
 - b. Charger shall automatically maintain battery in fully-charged float condition and be capable of providing full recharge in 12 hours.
 5. Unit controls shall energize the lamps automatically upon failure of the ac power supply and disconnect load before battery low-voltage limit is reached.

6. Housing: UV-stabilized, high impact, clear 0.120-inch polycarbonate or 18-gage steel, with a baked enamel finish.
7. Listing: UL listed for emergency lighting.
8. Acceptable Product: Kenall METEL-series LED or approved equal.

2.4 LIGHTING INSIDE EQUIPMENT ENCLOSURES

A. Luminaire:

1. Ceiling and side mounted, LED strip luminaire with clear, prismatic diffuser complying with UL 1570.
2. Minimum illuminance: 30 fc at 1.5 feet.
3. Color Temperature: 6000 K
4. Minimum Length: 6 inches less than cubicle width.
5. MTBF: 40,000 Hours
6. Acceptable Product: LBFA Lux Bar LED light bar, or approved equal.

B. Power Supply:

1. UL listed, sized for load.
2. Input: 125 Vdc
3. Output: Compatible with luminaire voltage.

2.5 FACTORY ASSEMBLY

A. General:

1. Luminaires shall be supplied from the substation ac panelboard.
2. Comply with NFPA 70.
3. Luminaire quantities and locations shown on Contract Drawings are for illustration purposes only and may not be adequate to achieve specified lighting levels. Locate luminaires and provide a quantity sufficient to achieve specified lighting levels.

B. Interior Luminaires:

1. Locate to illuminate the vertical surfaces of equipment.
 - a. Coordinate to avoid interference with overhead raceways or other major wiring or blocking of the light.
 - b. Luminaires shall not be mounted directly above equipment.
2. Switches:
 - a. Provide 3-way switches complying with requirements for switches in Section 34 21 17, TES Substation Design and Assembly.

- b. Mount inside by each entry door.
- C. Exterior luminaires: Locate on substation exterior walls to light all four sides of substation.
- D. Emergency lighting:
 - 1. Provide luminaires complete with lamps in place.
 - 2. Wire unswitched.
- E. Lighting inside equipment enclosures:
 - 1. Comply with NFPA 70.
 - 2. Supply luminaire power supplies from 125 Vdc power specified in Section 34 21 25, TES Dc Control Power.
 - 3. Power supplies shall not be wired in series. Luminaires shall not be wired in series.
 - 4. Provide lighting for control and power cubicles within the ac switchgear, transformer, rectifier, and dc switchgear cubicles.
 - 5. Locate on ceiling and sides to light the interior of each equipment enclosure.
 - 6. Control cubicles: Provide two top or side mounted light bars directed towards the component and terminal mounting panel.
 - 7. Transformer/rectifier enclosure: Provide two top mounted light bars for every 2 feet of enclosure width.
 - 8. Switching:
 - a. For each cubicle door, provide door switch as specified in Section 34 21 17, TES Substation Design and Assembly.
 - b. For each cubicle door with a viewing window, provide an external switch as specified in Section 34 21 17, TES Substation Design and Assembly, in addition to door switch.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Requirements of Article titled "Factory Assembly" apply to field installation.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

- A. The quantities of accepted work will be measured in the following units. All measurements will be plan measure except for authorized changes.
 - 1. Description: Lump Sum

4.2 PAYMENT

- A. Payment will be made at the respective unit or lump-sum price listed in the proposal and shall be full compensation for all labor, materials, and equipment necessary to complete the respective unit in place. There will be no separate measurement or payment for any item of work not specifically identified and listed in the proposal, and all such work shall be considered a subsidiary item with all costs pertaining thereto included in the prices for other items listed in the proposal. At the Engineer's option, partial payment may be made for any lump sum item listed in the proposal, providing that the Contractor is diligently and satisfactorily pursuing full completion of such partially complete item in accordance with the approved job progress schedule.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 34 21 19

TES DC SWITCHGEAR

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Dc switchgear for TES substations, including the following sections:
 - a. Negative switch (89N) and positive switch (89P) sections
 - b. Feeder breaker sections
- B. Number of dc circuit breakers and the configuration of each TES substation are shown on the Contract Drawings.

1.2 RELATED SECTIONS

- A. SECTION 34 21 06 – TES Common Work Results for Metals
- B. SECTION 34 21 08 – TES Dielectric Epoxy Flooring
- C. SECTION 34 21 17 – TES Substation Design and Assembly
- D. SECTION 34 21 18 – TES Lighting
- E. SECTION 34 21 25 – TES Dc Control Power
- F. SECTION 34 21 31 – TES Substation Automation System (SAS)
- G. SECTION 34 21 73 – TES Studies
- H. SECTION 34 21 80 – TES Spare Parts and Special Tools
- I. SECTION 34 21 90 – TES Testing

1.3 DEFINITIONS

- A. Intelligent Electronic Device (IED): See definition in Section 34 21 17, TES Substation Design and Assembly.

1.4 REFERENCED STANDARDS

- A. Section incorporates by reference the latest revisions of the following documents:
- B. Institute of Electrical and Electronics Engineers (IEEE)
 - 1. IEEE C37.14, Standard for Low-Voltage Dc Power Circuit Breakers Used in Enclosures
 - 2. IEEE C37.16, Standard for Preferred Ratings, Related Requirements, and Application Recommendations for Low-Voltage Ac (635 V and below) and Dc (3200 V and below) Power Circuit Breakers

3. IEEE C37.20.1, IEEE Standard for Metal-Enclosed Low-Voltage Power Circuit Breaker Switchgear
 4. IEEE C37.30.1, Standard Requirements for AC High-Voltage Air Switches Rated Above 1000 V
 5. IEEE C37.41, Standard Design Tests for High-Voltage (>1000 V) Fuses, Fuse and Disconnecting Cutouts, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches, and Fuse Links and Accessories Used with These Devices
 6. IEEE C37.90, Standard for Relays and Relay Systems Associated with Electric Power Apparatus
- C. International Electrotechnical Commission (IEC)
1. IEC 60077-1, Railway applications - Electric equipment for rolling stock - Part 1: General service conditions and general rules
 2. IEC 60077-3, Railway applications - Electric equipment for rolling stock - Part 3: Electrotechnical components - Rules for d.c. circuit-breakers

1.5 SUBMITTALS

- A. Procedures: Section 01 33 00, Submittal Procedures.
- B. Product Data: Complete manufacturer's product descriptions and catalog data, including information on the following:
1. Design and application ratings.
 2. Details of circuit breaker, internal components, arc chute, contacts, and closing and tripping mechanisms.
 3. Details of switchgear, drawout mechanism, interlocks, and shutters.
 4. Relays, controls, switches, indicators, load measuring devices, resistors and cubicle heaters.
 5. Key Operated Mechanical Interlock: Kirk key catalog data.
 6. Bus insulating material.
 7. Certified service performance, reliability and 5-year proven service history record, including a complete device history of the following:
 - a. Multi-function relays.
 - b. Circuit breakers.
- C. Spare Parts and Special Tools:
1. Submit a list of spare parts to be provided under this Section.
 2. Submit at the same time as product data.
 3. Provide part numbers for each part, including a detailed break down of each spare part assembly and set, as defined in Section 34 21 80, TES Spare Parts and Special Tools.

4. Submit a list of special tools to be provided under this Section, as defined in Section 34 21 80, TES Spare Parts and Special Tools.
- D. Shop Drawings:
1. Arrangement drawings.
 2. Schematic wiring diagrams.
 3. Interconnection diagrams.
 4. Bus insulating drawings.
- E. Complete details of transfer trip scheme.
- F. Kirk key scheme, including description, and detailed arrangement drawings.
- G. Testing:
1. Submit test procedures that meet the requirements of Section 34 21 90, TES Testing, for the following:
 - a. Factory Design Tests.
 - b. Factory Production Tests.
 2. Submit test reports that meet the requirements of Section 34 21 90, TES Testing, for the following:
 - a. Factory Design Tests.
 - b. Factory Production Tests.
- H. Operations and Maintenance Data:
1. Submit manufacturer's operating and maintenance instructions on products specified in this Section, including the following:
 - a. Manufacturer's operating and maintenance instructions, parts list, illustrations and diagram for components.
 - b. Wiring diagram.
 2. Submit immediately after approval of product data.

1.6 SPARE PARTS

- A. Provide spare parts in accordance with Section 34 21 73, TES Spare Parts and Special Tools.
- B. List below applies to items in this Specification Section.
1. Dc circuit breaker: Complete with truck and accessories. Provide 3 spares.
 2. Main contacts for dc circuit breaker: Provide 2 spare assemblies.
 3. Secondary contacts for dc circuit breaker: Provide 2 spare assemblies.
 4. Dc circuit breaker charging motors: Provide 2 spares.

5. Dc circuit breaker solenoids: Provide 2 spares.
6. Dc circuit breaker springs: Provide 2 spares.
7. Dc protective relays (non-IED): Provide 1 spare set.
8. Dc switchgear IEDs: Provide 1 spare set.
9. Dc ammeter and voltmeter: Provide 1 spare set, if separate from IEDs.
10. Dc switchgear control and auxiliary relays: Provide 1 spare set.
11. Transducers: Provide 1 spare set.
12. Dc switchgear control circuit fuses (if used): Provide 5 spare sets.
13. Dc mini circuit breakers (if used): Provide 1 spare of each rating.
14. Mechanical interlocks: Provide 1 spare set.

1.7 QUALITY ASSURANCE

- A. Comply with the requirements of the Project Quality Plan.
- B. Dc Switchgear:
 1. UL labeled or furnished with a Field Evaluation label in accordance with Section 34 21 17, TES Substation Design and Assembly.
 2. Dc switchgear including circuit breaker shall have 5 years successful operation in service at a transit application.
- C. Manufacturers of dc switchgear and components used in the dc switchgear shall be ISO 9001 certified.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Dc Switchgear: Dead-front, self-ventilated, metal enclosed, free standing, sheet steel enclosures suitable for indoor service.
- B. Circuit Breakers: Provide switchgear with individually enclosed, draw out type, high speed, power circuit breakers rated for use with the transformer-rectifier unit.
- C. Rear Access:
 1. Prefabricated TES Substation: Provide through exterior equipment doors and design such that positive feeder cables and negative return cables can be landed from the rear.
 2. VMF TES Substation: No rear access.
- D. Front Access:
 1. Prefabricated TES Substation: Provide access to removable components of the switchgear from the front.

2. VMF TES Substation: Provide access for landing positive and negative cables and access to removable components of the switchgear.
- E. Bus and Power Wiring:
1. Prefabricated TES Substation: Locate in rear.
 2. VMF TES Substation: Locate in rear, accessible from front.
- F. Complete Assembly: Include dc buses and connections, positive and negative feeder cable terminal connections, indicating lights, terminal blocks, protective and auxiliary relays, control circuitry, wiring and all other devices necessary to make a complete and operable switchgear assembly.
- G. Workmanship: Avoid wiring congestion, train wires neatly, protect wiring from sharp edges.
- H. Standards: Design, materials, construction, and tests shall be in accordance with IEEE C37.14, IEEE C37.20.1, and as further described or modified in this Section.
- I. Finish: Powder coat and color in accordance with Section 34 21 06, TES Common Work Results for Metals.

2.2 RATINGS

- A. The switchgear assembly and circuit breakers shall have the following minimum ratings in accordance with IEEE C37.14 and IEEE C37.16:

Full-Load Voltage	800 Vdc
Maximum Voltage	1000 Vdc
Continuous Current	1000 A
Minimum Frame Size	1000 A
Insulation Level:	
60 Hz withstand	3.7 kV rms
Short circuit rating	30 kA, peak

2.3 SWITCHGEAR ENCLOSURE

- A. Switchgear Structure:
1. Steel, rigid, self-supporting, self-contained, conforming to IEEE C37.20.1 and to requirements indicated below:
 2. Fabricated of electrically welded or bolted sheet steel, 11 gage minimum.
 3. Provide enclosures sufficiently rigid to support equipment under normal loads, short-circuit conditions, and specified seismic conditions.
 4. Apply coating to switchgear assembly in accordance with Section 34 21 06, TES Common Work Results for Metals.
- B. Doors: Sheet steel, 11 gage minimum, properly reinforced against distortion by suitable flanges and stiffening members.
1. Hinges: Heavy duty stainless steel.
 2. Latches: Minimum of three latches shall securely fasten door in the closed position and shall be easily opened without the use of tools.

3. Handle: Heavy duty, padlockable, opens all three latches, easily operated with one hand-motion, one for each door.
 4. Door stops: Heavy duty to hold door securely in the open position. Not easily bent if an attempt is made to close door without releasing door stop.
- C. Heaters: Provide two thermostatically-controlled strip-type heaters in each switchgear cubicle to prevent condensation.
1. Operating Voltage: Shall not exceed 50 percent of heater rated voltage.
 2. Thermostat:
 - a. Provide an individual thermostat for each cubicle.
 - b. Locate thermostat in a general area of each cubicle so that cool air at the lower portion of the enclosure can be sensed by the thermostat.
 3. Digital Heater Ammeter: Provide on the front of each cubicle enclosure to indicate current and operation of heaters.
 4. Power Source: 120 Vac auxiliary power system; use an isolation transformer.
- D. Lights: Provide inside equipment enclosures, as specified in Section 34 21 18, TES Lighting.
- E. Warning Signs:
1. Comply with requirements for warning signs in Section 34 21 17, TES Substation Design and Assembly.
 2. Provide signs on front, rear, and side access doors of cubicles where 600/750 Vdc wiring is present: "DANGER: LIVE PARTS" and "DANGER: HIGH VOLTAGE."
 3. Provide signs on removable rear access doors: "DANGER: HIGH VOLTAGE."
- F. Dc circuit breaker cubicle:
1. Suitable for accommodation of drawout circuit breakers.
 2. Supporting Guide Rails: Provide for positioning removable elements as an integral part of equipment.
 3. Design such that circuit breakers are easily drawn in or out of their housings.
 4. Include stationary disconnecting device contacts for the circuit breakers.
 5. Breakers shall connect or disconnect from buses and auxiliary circuits by means of self-aligning, self-coupling, primary disconnecting devices.
 6. Provide self alignment mechanisms such that misalignment of contact is not possible when circuit breaker elements make contact with stationary contacts.
 7. Control Wiring: Connection to the dc breaker may be by movable contacts or by a plug-style disconnect.
 - a. Plug style disconnect:
 - 1) It shall not be mechanically possible to rack breaker into the connected position with the plug disconnected.

- 2) Locate where easily accessible. Engineer will make final determination whether location is easily accessible.
 - 3) Provide heavy-duty connection hardware not easily bent or broken due to mishandling.
8. Provide suitable shrouds or automatic safety shutters on devices to prevent accidental contact with live parts.
 9. Provide each enclosure with protective shutters that cover live high-voltage terminals when the access door is opened or a dc feeder breaker is racked out of the cubicle.
 10. Provide each compartment with a hinged door or full width drawout panel for front access to the circuit breakers, instruments and terminal blocks.
 11. Provide rear access doors in prefabricated substations to facilitate access to the dc power bus. Doors shall swing fully open against the adjacent door or enclosures.
 12. Provide connections to the dc feeder cables in the rear compartment.
 13. Construct switchgear enclosures to allow for the dissipation of ionized gas from the circuit breaker arc chutes without hazard to personnel from the discharge of hot gas or other materials.
 - a. Release gas from the units to the outside of the switchgear enclosure by means of suitable stacks, louvered vent openings, or vent openings covered with grilles.
 - b. Provide adequate clearance to ground to prevent the possibility of establishing a conducting path to grounded structure or objects when interrupting maximum short-circuit energy at rated maximum voltage.
 - c. Line enclosure surfaces exposed to arcs or ionized gases with flame resistant, high dielectric insulating materials.
 - d. This paragraph is not intended to require the use of arc-resistant switchgear.
 14. Stacking of dc circuit breakers in cubicles is not permitted.
- G. Negative and Positive Switch Cubicles:
1. Mount positive and negative switches in separate isolated cubicles, either stacked or side by side.
 2. Negative switch may be provided as part of rectifier but must be isolated from rectifier.
 3. Cubicles shall have a hinged door with a clear window for viewing negative or positive switch position.
- H. Separate high voltage devices from low voltage controls:
1. If high voltage devices and low voltage controls are located in the same cubicle, identify high and low voltage by color coding mounting panels.
 2. No controls are allowed in rear cable and bus compartment.

- I. The control devices can share the same compartment with the protection devices.
 - 1. Control/protection compartment shall be dead-front and shall consist of hinged swinging panels mounted on the switchgear frame.
 - a. Construct swinging panel doors to support flush and semi-flush mounted devices.
 - b. Swinging panel doors shall not distort from a plane surface in any position.
 - c. Swinging panel doors of control/protection compartment shall be supported by stainless steel hinges.
 - d. Panel doors shall swing open and provide free access to the area behind the panel, the rear of the devices mounted on the panels, wiring, terminal blocks, and auxiliary devices mounted within the compartment.
 - e. Secure swinging panel doors in the closed position with two positive latching or screwed fasteners that can be operated by hand without tools.
 - f. Swinging panel doors shall open 90 degrees and be held with heavy duty stops.

2.4 BUS AND BUS CONNECTIONS

- A. Main horizontal dc switchgear bus shall be an extension of the rectifier bus, run the length of the dc switchgear. Tap to serve each circuit breaker.
- B. Bus: Electrical grade copper with high electrical conductivity, rated 1000 A.
- C. Bolted bus connections: Silver-plated copper.
 - 1. All connections to the bus shall be bolted.
 - 2. Applies to bus taps, circuit breaker connections, cable connections, and connections of devices such as transducers and shunts.
 - 3. Bolts: Silicon bronze of sufficient number and size for application. Minimum two bolts per joint.
 - 4. Washers: Provide a Belville washer for each bolt, properly sized for the application.
 - 5. Conductivity: Each joint shall have conductivity at least equal to that of the bus bar and shall be so clamped that no loss of conductivity will occur during the life of the switchgear.
- D. Insulation:
 - 1. Insulate main bus and feeder bus from each other by one of the following means:
 - a. Electrical insulating laminate barrier that completely encloses bus on both sides and both edges.
 - b. Insulating boot.
 - c. Insulated coating.
 - d. Other approved means.

2. Insulate connections to the bus using a boot.
 3. Mount bus bars on barrier-type insulation or post-type insulators.
- E. Strength: Bus, bus connections, and bus insulation shall withstand thermal and mechanical stresses resulting from maximum available short-circuit current or rms interrupting rating of circuit breakers whichever is greater, without damage or permanent distortion.

2.5 POSITIVE AND NEGATIVE DISCONNECT SWITCHES

- A. Provide a negative dc disconnect switch (Device 89N) and a positive dc disconnect switch (Device 89P) in each substation dc switchgear assembly, as shown in Contract Drawings. Each switch shall meet the following requirements:
1. Type: Manually-operated, single-pole, bolted-pressure type, solid copper blade with silver plated contacts.
 2. Rating: 1000 A continuous current at 1000 Vdc and withstand twice the expected rms bolted short circuit currents.
 3. Insulation level: Sufficient to pass 1 minute 60 Hz dry withstand test at 3.7 kV, rms.
 4. Handle: Provide an insulated operating handle.
 5. Switch Position Indication:
 - a. Provide a green and a red indicating light on the front panel of cubicle for each switch:
 - 1) Green illuminated: Switch open.
 - 2) Red illuminated: Switch closed.
 - b. Provide indication to SAS; see Section 34 21 31, TES Substation Automation System (SAS).
 - c. See Section 34 21 17, TES Substation Design and Assembly, for requirements for Device 33 position switch.
 6. Instructions: Provide a simple operation instruction nameplate on each cubicle door.
- B. Negative Disconnect Switch - 89N:
1. Connection: Install between the negative return cable and the rectifier negative pole.
 2. Interlock with Positive Switch:
 - a. Provide key interlock with positive disconnect switch to ensure negative switch can be opened only when positive switch is open.
 - b. Key removal from the negative disconnect switch shall be possible only when the negative disconnect switch is closed.
 - c. Opening of negative disconnect switch shall require the key to be inserted in the negative disconnect switch.

3. Interlock with Dc Circuit Breakers:
 - a. If negative switch is in the open position it shall not be possible to close a dc circuit breaker.
- C. Positive disconnect switch - 89P:
 1. Connection: Install between the rectifier output and the dc feeder breakers.
 2. Interlock with Negative Switch:
 - a. Key interlock with the negative switch to prevent positive switch from closing when the negative disconnect switch is open.
 - b. Key shall not be removable from the positive switch when the negative disconnect switch is closed.
 - c. With the key removed from the positive switch it shall be mechanically locked open.
 3. Interlock with Ac Switchgear: Key interlock to ensure no-load opening.

2.6 CIRCUIT BREAKERS

- A. Dc circuit breakers: Single-pole, air-break, high-speed, removable type.
 1. Manufacture in accordance with IEEE C37.14, and rate according to the preferred ratings listed in IEEE C37.16, except as indicated in this Section.
 - a. As an alternate, provide dc circuit breakers tested according to IEC 60077-1 and IEC 60077-3.
 2. Suitable for local and remote supervisory control.
 3. Electrically operated and electrically and mechanically trip-free with the mechanism insuring full contact pressure until time of opening.
 4. Insulated to withstand 3.7 kV, rms at 60 Hz for 1 minute.
 5. Peak rated momentary current: 30 kA, minimum.
- B. Instantaneous (Device 76): Provide each dc feeder circuit breaker with a direct-acting, bi-directional, instantaneous overcurrent tripping device adjustable between 150 percent and 350 percent of the breaker rating.
- C. Contacts:
 1. Surfaces of the moving and stationary contact members of the main contacts shall be silver, non-welding silver alloy, or equivalent that combines high conductivity and necessary arc-resistant properties.
 2. Main and secondary contacts of breaker shall be removable for replacement.
- D. Operating mechanism:
 1. Solenoid-operated or motor-charged stored-energy, spring-operated type.
 - a. Connect solenoid operated mechanisms such that the control voltage is removed from the closing coil after a preset time.

-
- b. In the event the breaker does not close or the closing control circuit is not opened, a trip sequence shall be initiated to open the closing control circuit and restore all closing sequence relays to their normal position.
 - c. Motor-charged and spring-operated mechanisms:
 - 1) Mechanism shall be designed to prevent overcharging.
 - 2) The mechanism shall ensure that the release of stored energy for closing the circuit breaker main contacts is prevented unless the mechanism has been fully charged.
 - 3) The stored-energy closing mechanism shall automatically charge itself within 15 seconds after closing of the breaker.
 - 4) Energy storage shall be sufficient for an open-close-open cycle at maximum rated short circuit current.
 - 2. Mechanism shall be non-pumping.
 - 3. Design shall ensure positive opening of the moving contacts and circuit interruption when the tripping impulse is received at the fully closed or any partially open position.
 - 4. Provide control with a shunt trip device with the necessary auxiliary control equipment.
 - E. Breaker Position: Make provisions for moving each breaker to a "connected", "test" and "disconnected" position with positive stops in each position.
 - 1. "Connected" position: Both the primary disconnecting devices and the secondary disconnecting devices shall be in full contact and the breaker shall be in position for normal operation.
 - 2. "Test" position: Primary disconnecting devices shall be open and separated by a safe distance and the secondary disconnecting devices shall be in full contact.
 - 3. "Disconnected" position: Both primary and secondary disconnecting devices shall be open and separated by a safe distance and shutter closed.
 - 4. Position Indicator: Provide an indicator to show the location of the circuit breaker in "connected," "test," or "disconnected" positions.
 - F. Mechanical and Electrical Interlocks:
 - 1. Mechanical:
 - a. Provide interlock to prevent moving circuit breaker in or out of the "connected" position when circuit breaker main contacts are in the closed position.
 - b. Provide interlock to prevent closing the circuit breaker manually unless the breaker is in the "test" or "disconnected" position.
 - 2. Electrical: Provide interlock to prevent closing circuit breaker electrically, unless the circuit breaker is in the "connected" position with the primary disconnecting devices in full contact, or in the "test" position.

- G. Breaker Control:
1. Breaker control switch: Incorporate into SAS HMI and dc breaker protective IED. For additional information on SAS HMI see Section 34 21 31, TES Substation Automation System (SAS), .
 - a. Breaker in Connected Position: Breaker control by SAS HMI.
 - b. Breaker in Test Position: Breaker control by dc breaker IED HMI.
 - c. Request to close a dc feeder breaker shall be governed by the load measure reclose system. See Protective Devices article, below, for details of the load measure reclose system.
 - d. Provide sufficient logic to ensure that a response to an HMI or remote supervisory closure request will not result in an unsafe condition or cause damage to the substation or any of its components.
 2. Bypass Load Measuring:
 - a. Provide control on SAS HMI that allows an authorized operator to bypass load measure system when closing breaker.
 - b. See Section 34 21 31, TES Substation Automation System (SAS) for details of operation.
 3. Manual trip:
 - a. Provide each circuit breaker with mechanical means for manually tripping the circuit breaker in the "test" and "connected" positions.
 - b. This function shall be available with the compartment door closed.
 4. Control power: Provide from 125 Vdc control power system per Section 34 21 25, TES Dc Control Power.
- H. Indication:
1. Electrical:
 - a. Provide red and green indicating lights on each breaker unit for electrical closing and opening of the breaker while in the "test" or "connected" positions.
 - 1) Red light illuminated: Breaker closed.
 - 2) Green light illuminated: Breaker open.
 - 3) Provide long life, high brightness and high visibility, LED array lights.
 - b. Provide indication to SAS; see Section 34 21 31, TES Substation Automation System (SAS).
 2. Mechanical: Provide a mechanical indicator, visible when the door is closed, to show when the circuit breaker is in the "open" and "closed" condition.

-
- I. Auxiliary Contacts:
 - 1. Provide a minimum of four electrically separate sets of reversible auxiliary contacts, in addition to those required for the circuit breaker control circuit.
 - 2. Auxiliary contacts shall be operated by the breaker mechanism in both the "connected" and "test" position.
 - 3. Spare auxiliary contacts shall be wired to the outgoing terminal blocks.
 - J. Arc chutes:
 - 1. Metal plate or magnetic coil type.
 - 2. Suitable for bidirectional current flow.
 - 3. Designed for positive interruption of currents from 0 A to circuit breaker maximum rating.
 - 4. Provide with an air puffer device to extinguish low-current arcs.
 - K. Operations Counter: Provide four digit, non-resettable, register type mechanical operations counter on each circuit breaker to record tripping operations.
 - L. Lockout Provisions:
 - 1. Provide means to permit padlocking the dc breaker in the open position to prevent inadvertent closure without having to withdraw the breaker element.
 - 2. Padlocking means shall not allow breaker to be inserted further than the test position.
 - M. Breaker Truck Wheels:
 - 1. Provide circuit breakers with approved wheels to remove element from cubicle.
 - 2. Fifth Wheel:
 - a. If breaker truck cannot be easily turned when outside the breaker cubicle, provide a fifth wheel.
 - b. Engineer will make the determination whether breaker truck can be easily turned.
 - c. Wheels shall not damage epoxy floor coating.
 - N. Interchangeability:
 - 1. Removable elements of the same type and rating shall be completely physically and electrically interchangeable.
 - 2. Removable elements not of the same type of rating shall not be physically interchangeable.

2.7 TES SUBSTATION DC CABLE CONNECTIONS

- A. Bottom or top feed for negative and positive dc feeders, as required.
- B. Provide ample space for pulling and terminating the feeder cables entering or leaving the switchgear without requiring a less than specified cable bending radius.

- C. Provisions shall be made for the termination of up to four 250 kcmil, 2 kV dc positive cables in each feeder breaker section.
- D. Provide for the termination of up to eight 250 kcmil, 2 kV dc negative return cables on load side of the negative disconnect switch.

2.8 PROTECTIVE DEVICES

- A. General Requirements:
 - 1. Protective relays and multifunction relays provided in dc switchgear shall be Intelligent Electronic Devices (IED) equipped with communication function.
 - 2. Built-in Functions:
 - a. Control.
 - b. Measurement.
 - c. Fault recording: Capture real-time voltage and current for a triggered event with pre- and post-trigger sampling data useful for analyzing trip information, and store in non-volatile memory.
 - 3. Alarm Communication: Send alarms to SAS via protocol specified in Section 34 21 31, TES Substation Automation System (SAS).
 - 4. Screens: LCD.
 - 5. Time Synchronization: Protective IEDs shall synchronize time with SAS.
 - 6. Protective Device Coordination: Perform a coordination study for the dc system in accordance with Section 34 21 73, TES Studies, to obtain preliminary relay settings.
 - 7. Final Settings: Make final adjustments to relaying systems and protective devices during TES Substation Field Acceptance Testing and Integrated Testing specified in Section 34 21 90, TES Testing.
 - 8. Contact Wire Thermal Rise: Set instantaneous and sustained current curves to limit the contact wire thermal rise to less than 165 degrees F.
 - 9. Complete Installation: Provide additional components such as auxiliary relays, isolating diodes and similar devices not shown in the Contract Drawings, but required for a complete installation.
- B. Arrangement and Appearance:
 - 1. Arrange devices such as auxiliary relays, indicating lights and test plugs to be conveniently accessible and easily visible.
 - 2. IED meters and displays shall be located such that they are easy for a person standing at floor level to operate and read.
 - 3. The grouping shall be modular and place related functions in proximity.
 - 4. Mount devices plumb and square with the lines of the panels and mount as recommended by the manufacturer and approved by Engineer.
 - 5. Auxiliary devices shall match the general appearance as far as possible with frames of a compatible approved color and finish.

6. Devices of the same general type shall be manufactured by the same company and shall be similarly arranged and mounted.
 7. Refer to substation one-line diagram in the Contract Drawings for arrangement of protective relays and devices.
- C. At a minimum, provide the following protective functions/devices as shown below and on the substation one-line diagram in the Contract Drawings. Additional protective functions/devices recommended by equipment manufacturers may be installed with Engineer approval.
1. Dc Feeder Multifunction Relay IED:
 - a. Acceptable Manufacturer/Product: Siemens Sitras Pro, or approved equal.
 - b. Functions: Include the following at minimum:
 - 1) Overcurrent: At minimum, provide the following overcurrent protection functions, which shall operate in the forward and reverse current directions:
 - a) Instantaneous Overcurrent Trip.
 - b) Low Level Fault Trip and associated time delay.
 - c) Timed Overcurrent Trip:
 - i. Provide timed overcurrent trip function with inverse time characteristic that can be graphed with the set current, I_{tmd} , as the y-axis, and the time delay, T_{mdDel} , as the x-axis.
 - ii. Tripping shall be initiated when the load current exceeds the set current during the period of time t such that (t/ T_{mdDel}) and (I_{load}/ I_{tmd}) correspond to a point on the curve.
 - 2) Rate of Rise Trip: Shall be initiated if all of the following conditions are met:
 - a) Current di/dt exceeds the trip limit, di/dt .
 - b) Di/dt stays above the trip limit during the delay time, Delay.
 - c) During the delay time current exceeds the current rise limit.
 - c. Load Measure and Reclose:
 - 1) Provide each dc feeder cubicle with a set of automatic reclosing functions and equipment, including the following:
 - a) Load measuring function (Device 82).
 - b) Adjustable time delay reclosing function (Device 83).

- c) Load measuring resistors mounted on the top of the circuit breaker cubicle;
 - d) Associated accessories.
- 2) Initiate the load measuring and automatic reclosing cycle when either the dc circuit breaker receives a "close" command (from the local or remote control), or when the circuit breaker is tripped automatically and attempts to reclose.
 - 3) A "lockout" status or intentionally initiated trip of the dc lockout relay shall disable the load measuring and automatic reclosing cycle.
 - 4) Precede initiation of the load measuring cycle by an adjustable time delay to permit the faulted line section to become fully de-energized.
 - 5) At the commencement of the load measurement cycle, a voltage sensor shall determine whether there is no voltage on the section.
 - 6) If the voltage measuring circuit detects potential on the section, it shall reclose the associated circuit breaker immediately, providing that this potential is greater than a preset value.
 - a) The pickup setting shall be adjustable over the range of 60 to 750 Vdc.
 - b) Initially the pickup voltage shall be set to 560 Vdc.
 - 7) If the voltage measuring circuit detects no potential on the section, the load measuring function shall make repeated load measurements at suitable adjustable time intervals.
 - 8) If a load measurement determines that no fault is present, initiate automatic reclosing of the circuit breaker.
 - 9) A successful reclosure with no automatic trip within five seconds shall complete the measurement cycle and reset the devices to their initial state.
 - 10) Make provision for selection of up to six attempts to complete a successful load measurement and automatic reclosing cycle at 15 second intervals, within a 3 minute period. Set initially at three attempts.
 - 11) If no successful reclosure takes place in the three minute period, the automatic reclosing and load measuring system shall lock out the feeder breaker from closing.
 - 12) Provide each automatic reclosing and load measuring function with test facilities that shall check the functioning of all devices.
 - a) Initiate test cycle with a local "test" push-button, which shall be functional only when the circuit breaker removable element is in the "test" position.

- b) Circuit breaker shall not close until after completing automatic reclosing and load measuring test when the breaker is in the "connected" position.
- 13) Monitor condition of reclosure device.
- d. Incomplete Sequence (Device 148):
 - 1) This function shall detect the failure of a dc circuit breaker to clear a fault within a predetermined time.
 - 2) This function shall actuate the ac lock-out relay (Device 86) when actuated.
- e. Transfer Trip:
 - 1) Provide two types of transfer trip:
 - a) The first type shall be automatically resettable (Device 85). Automatic resetting shall be controlled by the load measure reclose relay and occurs on di/dt faults.
 - b) The second type shall require manual resetting (Device 85L). It shall trip the dc lockout relay (Device 186H) in both the originating and receiving substations, and is required for dc instantaneous over-current, frame faults, rail-to-earth potential faults, incomplete sequence faults, and emergency shutdowns.
 - 2) Configure communication interface devices between substations for transfer trip function over the communications network.
 - 3) Provide communication function blocks or other programming required for relays and IEDs to establish relay-to-relay communication between substations.
 - 4) Monitor the condition of the communication continuously.
 - 5) Generate an alarm if a fault condition is detected.
 - 6) Tripping of a dc breaker shall initiate tripping of the remote active breaker feeding the same power section. If a substation is bypassed, the local breaker shall send the transfer trip signal to the substation beyond the bypassed substation to de-energize the power section.
 - 7) Transfer trip shall be integral to protection relays.
 - 8) Communication for transfer trip must be configured using VLAN. See Section 34 21 31, TES Substation Automation System.
- 2. Reverse Current:
 - a. Provide reverse current detection (Device 32).
 - b. The protection shall detect current flow from the distribution bus into the rectifier unit and trip and lock out the dc feeder breakers and ac circuit breaker.

- c. The trip level shall be initially set to 15 percent of the rated current or as approved by Engineer.
- 3. High Resistance Frame Fault:
 - a. Insulate dc switchgear enclosure from ground.
 - b. Single-point ground enclosure through a separate high resistance ground IED device 64HS (hot structure) and 64GS (grounded structure).
 - 1) Connect IED with insulated 4/0 AWG copper conductor directly to substation ground mat.
 - 2) The 64HS and GS relay shall be the only ground path to the enclosure.
 - 3) The occurrence of any other ground path must be detected and alarmed.

2.9 INSTRUMENTS AND METERS

- A. Instruments and meters shall be integrated into intelligent electronic devices (IEDs).
 - 1. Voltmeters and ammeters shall be rated for use with the corresponding transducers.
 - 2. Scales shall be of a suitable range, equal to the associated potential or current transformer primary rating.
- B. Provide instrument and metering IEDs with capability of communicating with SAS as specified in Section 34 21 31, TES Substation Automation System (SAS).
- C. Instruments and metering devices for measuring dc values shall receive their inputs from isolation converters that shall be provided within the bus compartment of the switchgear.
 - 1. Provide auxiliary devices required for operation of the converters.
 - 2. Provide suitable isolation and insulation in order to ensure safe operation in contact with personnel.
 - 3. VMF Switchgear: Design to be maintainable from the front.

2.10 FACTORY ASSEMBLY

- A. Completely insulate dc switchgear enclosure and rectifier from ground and from the rectifier transformer and the ac switchgear.
 - 1. Insulate and isolate dc switchgear and rectifier from the floor using an epoxy floor covering in accordance with Section 34 21 08, TES Dielectric Epoxy Flooring.
 - 2. Insulate and isolate dc switchgear and rectifier from the transformer using electrical laminate in accordance with Section 34 21 17, TES Substation Design and Assembly.
 - 3. Insulate walls using electrical laminate in accordance with Section 34 21 17, TES Substation Design and Assembly, and as shown on Contract Drawings.

2.11 SOURCE QUALITY CONTROL**A. Factory Design Tests:**

1. Dc Switchgear: Perform Design Tests as specified in IEEE C37.20.1:
 - a. Dielectric tests
 - b. Rated continuous current tests
 - c. Short-time withstand current tests
 - d. Short-circuit current withstand tests
 - e. Mechanical endurance tests
 - f. Flame resistance tests
 - g. Rod entry test
 - h. Coating (paint) qualification test
2. Dc Circuit Breaker: Perform Design Tests as specified in IEEE C37.14.
3. Positive and Negative Disconnect Switches:
 - a. Conduct a complete set of design tests on one switch of each type in accordance with IEEE C37.30.1 and IEEE C37.41.
 - b. Tests to be performed with switch(es) in enclosure assembled in closed, final operational configuration.
4. Dc Protection Relays and Control Devices:
 - a. Perform in accordance with Design Tests in IEEE C37.90.
 - b. Frame Fault Relay (Device 64 HS and GS): Following design tests are required.
 - 1) Continuous and maximum short circuit ratings: Demonstrate by test.
 - 2) Response time and maximum trip time: Demonstrate by test.
 - 3) Maximum trip time for this device shall not exceed 50 ms.

B. Factory Production Tests:

1. Dc Switchgear: Perform during TES Substation Factory Acceptance Tests in accordance with Section 34 21 90, TES Testing.
2. Dc Circuit Breaker:
 - a. Prior to mounting inside dc switchgear, perform the following on each dc circuit breaker in accordance with IEEE C37.14:
 - 1) Calibration test
 - 2) Control, secondary wiring and device check test.

- 3) Dielectric withstand voltage test.
- 4) No-load operation test.
- b. Perform additional testing on each dc circuit breaker after mounting in switchgear during TES Substation Factory Acceptance Tests in accordance with Section 34 21 90, TES Testing.
- 3. Positive and Negative Disconnect Switches: Perform during TES Substation Factory Acceptance Tests in accordance with Section 34 21 90, TES Testing.
- 4. Dc Protection Relays, Control Devices and Meters: Perform in accordance with production tests in IEEE C37.90.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Insulate dc switchgear in built-in-place substation as required in Part 2, above, in the article titled "Factory Assembly."

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

- A. The quantities of accepted work will be measured in the following units. All measurements will be plan measure except for authorized changes.
 - 1. Description: Lump Sum

4.2 PAYMENT

- A. Payment will be made at the respective unit or lump-sum price listed in the proposal and shall be full compensation for all labor, materials, and equipment necessary to complete the respective unit in place. There will be no separate measurement or payment for any item of work not specifically identified and listed in the proposal, and all such work shall be considered a subsidiary item with all costs pertaining thereto included in the prices for other items listed in the proposal. At the Engineer's option, partial payment may be made for any lump sum item listed in the proposal, providing that the Contractor is diligently and satisfactorily pursuing full completion of such partially complete item in accordance with the approved job progress schedule.

END OF SECTION

SECTION 34 21 23**TES TRANSFORMER-RECTIFIER UNIT****PART 1 - GENERAL****1.1 SUMMARY**

- A. This Section includes rectifier-transformers and rectifiers, which are referred to in this Section as the "Transformer-Rectifier Unit," for the TES substations.

1.2 RELATED SECTIONS

- A. SECTION 01 33 00 – Submittal Procedures
- B. SECTION 34 21 06 – TES Common Work Results for Metals
- C. SECTION 34 21 08 – TES Dielectric Epoxy Flooring
- D. SECTION 34 21 13 – TES Switchboards
- E. SECTION 34 21 17 – TES Substation Design and Assembly
- F. SECTION 34 21 18 – TES Lighting
- G. SECTION 34 21 18 – TES Medium-Voltage Ac Switchgear
- H. SECTION 34 21 31 – TES Substation Automation System (SAS)
- I. SECTION 34 21 80 – TES Spare Parts and Special Tools
- J. SECTION 34 21 90 – TES Testing
- K. SECTION 34 22 10 – TES Low-Voltage Conductors and Cable

1.3 REFERENCED STANDARDS

- A. Section incorporates by reference the latest revisions of the following documents:
- B. American Society for Testing and Materials (ASTM)
 - 1. ASTM D116, Vitrified Ceramic Materials for Electrical Applications
- C. Institute of Electrical & Electronics Engineers (IEEE)
 - 1. IEEE 519, Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems
 - 2. IEEE 1653.2, Standard for Uncontrolled Traction Power Rectifiers for Substation Applications Up to 1500 Vdc Nominal Output
 - 3. IEEE C37.20.3, Standard for Metal-Enclosed Interrupter Switchgear
 - 4. IEEE C57.12.01, General Requirements for Dry-Type Distribution and Power Transformers Including Those with Solid-Cast and/or Resin Encapsulated Windings

5. IEEE C57.12.91, Standard Test Code for Dry-Type Distribution and Power Transformers
 6. IEEE C57.18.10, Standard Practices and Requirements for Semiconductor Power Rectifier Transformers
- D. National Electrical Manufacturers Association (NEMA)
1. NEMA TR 1, Transformers, Regulators and Reactors
 2. NEMA SG 6, Power Switching Equipment

1.4 SUBMITTALS

- A. Procedures: SECTION 01 33 00 – Submittal Procedures.
- B. Product Data: Manufacturer's product descriptions and catalog data for the following:
 1. Transformer-Rectifier Unit
 - a. Enclosures: Gauge of steel, finish, door hardware.
 - b. Relays, protective devices, control switches, over temperature devices and failed diode indication device.
 - c. Ratings.
 - d. Internal wiring: Wire type and size.
 - e. Information concerning design and application ratings.
 - f. Information concerning service, performance and reliability.
 - g. Documents confirming the substation system rating.
 2. Rectifier:
 - a. Bus and bus insulators.
 - b. Diodes
 - c. Fuses
 - d. Dc surge arresters
 - e. Cooling fans
 3. Rectifier-transformer:
 - a. Bus and bus insulators.
 - b. Core steel.
 - c. Transformer winding insulation system.
 - d. Transformer Data: Weight, impedance, and primary and secondary BIL
 - e. Transformer temperature monitor.
 4. Interphase transformer

- C. Spare Parts and Special Tools:
1. Submit a list of spare parts to be provided under this Section.
 2. Submit at the same time as product data.
 3. Provide part numbers for each part, including a detailed break down of each spare part assembly and set, as defined in SECTION 34 21 80 – TES Spare Parts and Special Tools.
 4. Submit a list of special tools to be provided under this Section, as defined in SECTION 34 21 80 – TES Spare Parts and Special Tools.
- D. Shop Drawings:
1. Transformer-Rectifier Unit
 - a. Detail drawings for transformer-rectifier unit, including interphase transformer, surge arrester arrangement, and connection between rectifier and transformer.
 2. Rectifier:
 - a. Outline drawing showing dimensions, front, back and side elevations of enclosure, overall dimensions, and lifting lugs.
 - b. Detail drawing of connection between rectifier and positive switch
 - c. Rectifier enclosure and door latch details.
 - d. Rectifier nameplate drawing.
 - e. Wiring, schematic, and connection diagrams.
 - f. Rectifier monitoring and protection schematic and wiring diagram.
 - g. Bill of materials.
 3. Rectifier-Transformer:
 - a. Outline drawing showing dimensions, front, back and side elevations of enclosure, overall dimensions, and lifting lugs.
 - b. Detail drawing of connection between Ac main breaker and rectifier-transformer.
 - c. Transformer enclosure and door latch details.
 - d. Transformer nameplate drawing with nameplate details.
 - e. Wiring, schematic, and connection diagrams.
 - f. Insulation system details.
 - g. Transformer primary and secondary busing arrangements showing bus construction details
 - h. Transformer tap changer arrangement details.
 - i. Bill of materials.

4. Transformer temperature monitor/protection device schematic and wiring diagram including the location of the temperature sensor.
- E. Calculations:
1. Transformer design calculations, including hottest spot temperature rise in accordance with IEEE C57.12.01.
 2. Transformer calculation of winding temperature during a short circuit in accordance with IEEE C57.12.01.
 3. Bus sizing calculations: Rectifier and rectifier-transformer.
 4. Proof the transformer-rectifier unit design and construction conforms to IEEE 519.
- F. Submit the following upon completion of transformer manufacture:
1. Measured present worth of transformer energy losses, including the following:
 - a. Table 1, with actual measured losses from the transformer.
 - b. Table 2 calculation, using the new value from Table 1.
 2. Comparison of calculated and measured present worth of transformer energy losses, as described in the Article below titled "Transformer Design Optimization."
- G. Submit test procedures that comply with Section 34 21 90, TES Testing.
1. Design Tests.
 2. Production Tests.
- H. Submit test reports that comply with Section 34 21 90, TES Testing.
1. Design Tests: Provide design test reports for each type of transformer-rectifier unit within 30 Days after completion of testing.
 2. Production Tests: Provide production test reports for each transformer-rectifier unit within 30 Days after completion of testing.
- I. Operations and Maintenance Data:
1. Submit manufacturer's operating and maintenance instructions on products specified in this Section, including the following:
 - a. Submit manufacturer's operating and maintenance instructions, parts list, illustrations and diagram for components for products specified in this Section.
 - b. Wiring diagram.
 - c. Diagram showing recommended safety grounding during maintenance.
 2. Submit immediately after approval of product data.

1.5 SPARE PARTS

- A. Provide spare parts in accordance with SECTION 34 21 80 – TES Spare Parts and Special Tools.

- B. List below applies to items in this Specification Section.
 - 1. Rectifier-transformer: Provide 1 spare.
 - 2. Transformer temperature monitor complete with temperature sensors: Provide 1 spare assembly.
 - 3. Rectifier diodes: Provide 7 spare.
 - 4. Rectifier diode protection fuses: Provide 7 spare.
 - 5. Rectifier over-temperature: Provide 7 spare assemblies.
 - 6. Interphase transformer: Provide 1 spare.

1.6 QUALITY ASSURANCE

- A. Comply with the requirements of the Project Quality Plan.
- B. Rectifier-transformer shall be UL labeled or shall be furnished with a Field Evaluation label in accordance with Section 34 21 17, TES Substation Design and Assembly.
- C. Rectifier shall be UL labeled or shall be furnished with a Field Evaluation label in accordance with Section 34 21 17, TES Substation Design and Assembly.

1.7 WARRANTY

- A. Provide an extended warranty of 5 years for rectifier-transformers.

PART 2 - PRODUCTS

2.1 TRANSFORMER-RECTIFIER UNIT - GENERAL REQUIREMENTS

- A. Transformer-rectifier unit shall be manufactured in accordance with the referenced standards.
- B. Transformer-rectifier unit consists of a separate rectifier-transformer and a rectifier, as shown on Contract Drawings.
 - 1. Provide each unit complete with auxiliaries, controls, wireways, interconnecting ac and dc buses, enclosures and necessary hardware, wiring and devices from the high voltage side of the transformer to the dc bus connections to the dc switchgear and negative enclosure.
 - 2. Except as otherwise specified, the transformer-rectifier shall conform to IEEE C57.12.01, C57.12.91, 519, and 1653.2, and NEMA SG 6 and TR 1.
- C. Dc output of the transformer-rectifier unit shall feed the metal enclosed dc switchgear that controls and protects the power supply to the Overhead Contact System (OCS).
- D. Enclosures for Transformer and Rectifier:
 - 1. Construct from sheet steel, 11 gage minimum, properly reinforced against distortion by suitable flanges and stiffening members.
 - 2. Doors:
 - a. Minimum 11 gage sheet steel.

- b. Doors 36 inches or wider shall include vertical stiffeners, minimum 3 stiffeners for a 36-inch door, with one additional stiffener for each additional 12 inches of door width.
- 3. Finish: Powder coat in accordance with 34 21 06, TES Common Work Results for Metals.
- 4. Color: In accordance with Section 34 21 06, TES Common Work Results for Metals.
- E. Design Loading Condition: Transformer-rectifier units shall meet the duty cycle specified in IEEE 1653.2 for extra heavy traction service.
- F. Efficiency: Overall efficiency of each transformer-rectifier assembly shall be greater than 98 percent at its continuous rating.
- G. Power Factor: Displacement power factor of each transformer-rectifier assembly shall be 0.95 or greater from 25 percent to full load at rated ac voltage.
- H. Voltage Regulation:
 - 1. Minimum 4-1/2 percent between 1 percent and 200 percent load with the nominal ac voltage maintained at the transformer primary and the transformer set at the rated voltage tap.
 - 2. Engineer may allow minor variations in regulation based upon submitted design curve.
- I. Dummy Load:
 - 1. Limit the no-load voltage to the value specified.
 - 2. Provide a bleeder resistance dummy load, if required, to prevent excessive voltage rise at no-load.
- J. Provide protection against transient surge voltages on the dc side of the rectifier. If fuses are used in suppression networks, they shall be monitored by visual indicators and equipped with indication devices wired to local Annunciator.
- K. Short Circuit Ratings:
 - 1. Design transformer, including terminal connections and buswork, to withstand a full short circuit with shorted low-voltage terminals and rated voltage on the high-voltage terminals, in accordance with IEEE C57.12.01. The duration of the short-circuit current shall be minimum 1 second.
 - 2. Design all parts of the rectifier unit, including the terminal connections and buswork, to withstand a maximum dc fault on the dc positive bus, without damage, for the period required for the back-up protection to operate and open the ac circuit breaker.

2.2 TRANSFORMER-RECTIFIER UNIT RATINGS AND CONFIGURATION

- A. Mainline transformer-rectifier units:
 - 1. Rating: 750 Vdc, 350 kW measured at output terminals.
 - 2. Configuration: 12-pulse, double-way, in accordance with IEEE 1653.2, Circuit 31.

3. Convert 13.2 kV, 60 Hz ac, three-phase, three-conductor primary power to 750 Vdc at 100 percent of full load.
 4. Ac power source: 13.2 kv switchgear; see Section 34 21 18, TES Medium-Voltage Ac Switchgear.
- B. VMF transformer-rectifier unit:
1. Rating: 750 Vdc, 150 kW measured at output terminals.
 2. Configuration: 6-pulse, in accordance with IEEE 1653.2.
 3. Convert 480 V, 60 Hz ac, three-phase, three-conductor primary power to 750 Vdc at 100 percent of full load.
 4. Ac power source: 480 Vac switchboard; see SECTION 34 21 13 – TES Switchboards.

2.3 PROTECTIVE DEVICES AND RELAYS FOR TRANSFORMER-RECTIFIER UNIT

- A. Coordinate protection to prevent false tripping or malfunction.
- B. Supply an insulating dust cover for each internally-mounted device or the chamber that accommodates these devices.
- C. Compartment: Mount control devices, relays and protective devices within the rectifier and transformer enclosure within a separate barriered compartment in compliance with IEEE C37.20.3.
1. Devices shall be readily accessible without disassembling interior portions of the rectifier assembly.
 2. Control wiring shall be contained within the cubicle.
 3. Control wiring shall be barriered from and not intermixed with 750 Vdc power wiring.
 4. No 750 Vdc devices shall be mounted in control compartment.
 5. Locate devices such that heat from other equipment does not affect operation.
- D. Control Power: Power supply for protective devices and relays shall use 125 Vdc auxiliary power system.
- E. Transformer Temperature Monitor (TTM) Device 49:
1. Shall be manufactured for the purpose and have a service proven history.
 2. Shall incorporate a hot-spot winding temperature indicator located where the highest temperature reading is obtained during Design testing.
 3. Provide with two-step, electrically independent contacts that close on rising temperatures for alarm (first step) and tripping (second step).
 - a. First stage, 49T1:
 - 1) Initiate an alarm on the TTM and SAS. Refer to Section 34 21 31 – TES Substation Automation System (SAS).

- 2) Set initially at the temperature reached during the 2-hour heat run at 150 percent rated output, and annunciate when this temperature is reached.
 - b. Second stage, 49T2: Initiate an alarm on the TTM and SAS, trip and lock out the main ac breaker, and open the main dc circuit breaker.
 - c. Temperature set points, T1 and T2, shall be factory-preset when transformer is provided, as recommended by the manufacturer and approved by Engineer, and field adjustable
4. Display temperature continuously on a digital display mounted on the surface of transformer panel.
 - a. Accuracy: Within 1.5 percent of the full-scale reading.
 - b. Scale: Degrees Celsius.
 - c. Peak Temperature:
 - 1) Peak temperature shall be displayed when requested by the activation of a front panel mounted pushbutton.
 - 2) Peak temperature shall be resettable via a separate front panel mounted pushbutton.
 - 3) TTM shall store the peak temperature reached by the rectifier-transformer.
5. Enclosure:
 - a. NEMA 1 enclosure for low voltage terminals.
 - b. Cover: Hinged- or screw-type.
6. Terminal strips: Provide covers and mount on back panel.
7. Barriers: Provide where necessary to separate conductors with different voltage insulation ratings, such as thermocouple wiring and 125 Vdc control wiring.
8. Mounting Securely mount enclosure to the transformer frame.
 - a. Mount in a location readily accessible from the front as indicated, but not to restrict access to the transformer coils for maintenance.
 - b. Do not mount the enclosure in removable panels.
9. Control Wiring:
 - a. Control wiring shall be 600 V switchboard wire. See Section 34 22 10, TES Low-Voltage Conductors and Cable, for switchboard wire requirements.
 - b. Size: Minimum 14 AWG, except for temperature sensor internal wiring.
10. Contacts: Electrically separate and suitable for operation at 125 Vdc.

- F. Provide the following protective devices for the rectifier. Contacts on these devices shall be electrically separated:
1. Rectifier over-temperature (Device 26):
 - a. Over temperature device shall be factory set, two stages (26R1 and 26R2).
 - b. Shall detect first an abnormal rise in diode heat sink or diode temperature and initiate local and remote annunciation.
 - c. Set-point for the alarm shall be set during the factory systems test to the level recorded during the two hour 150 percent heat run.
 - d. An additional rise in heat sink temperature will trip and lock out the ac main breaker, open the main positive circuit breaker and shall alarm on the SAS. Refer to SECTION 34 21 31 – TES Substation Automation System (SAS).
 - e. Devices shall be isolated from the bus voltage.
 2. Frame fault protection for the rectifier: Provide high resistance frame fault protection for the rectifier cubicles.
 3. Provide failed diode indications 98R1 and 98R2.
 4. Refer to Contract Drawings for additional protective devices.

2.4 RECTIFIER

- A. General:
1. Provide rectifier assembly as an integral part of the dc switchgear.
 2. Rectifier assembly shall be constructed in accordance with IEEE C37.20.3, except as modified in this Section.
 3. Rectifier shall include silicon diodes, internal buses, terminals for connection to external power and control wiring or buses, shunts, base or bleeder load resistors, protective devices, control wiring, terminal blocks, compartments, cubicles, and all other necessary accessories.
 4. All rectifier assemblies shall be identical, except for necessary differences in the VMF rectifier.
- B. Rating and configuration:
1. IEEE 1653.2 extra heavy traction service.
 2. Dc Insulation: 1200-Volt Class.
 3. Mainline rectifiers:
 - a. Rated 750 Vdc, 350 kW, with natural convection air cooling.
 - b. Continuous current rating at 100 percent: 583 A.
 - c. Twelve-phase, double-way, 12-pulse rectification.

4. VMF rectifier:
 - a. Rated 750 Vdc, 150 kW, with natural convection air cooling.
 - b. Continuous current rating at 100 percent: 250 A.
 - c. Six-phase, double-way, 6-pulse rectification.
 5. Cooling fans:
 - a. Provide fans for forced air cooling to increase continuous current rating by 33 percent.
 - b. Rectifier shall not suffer loss of life when operated at the IEEE 1653.2 extra heavy traction service overload.
- C. Enclosure:
1. Mount rectifier assembly in a metal fully-enclosed switchgear section or compartment.
 2. The switchgear section shall be indoor, self-ventilated, metal enclosed structure with barriers, compartments, hinged doors as required by IEEE C37.20.3, except as modified in this Section.
 3. Assemble enclosure with a rigid self-supporting structural steel framework.
 - a. Structural members shall be of sufficient strength to support the buswork under short circuit conditions.
 - b. Principal structural members shall be electrically welded or bolted together.
 - c. Provide lifting eyes for lifting the rectifier unit from the top.
 - d. The completed package shall be capable of being skidded or rolled any direction.
 - e. Provide jacking lugs at each base corner.
 4. Doors:
 - a. Provide convenient access doors on the front and rear of the section for normal maintenance and inspection.
 - b. Latches: Equip each door with a heavy duty latch to hold the door fully and securely closed.
 - c. Hinges: Stainless steel heavy-duty type.
 - d. Door Stops:
 - 1) Provide heavy-duty door stops to hold the door in the open position.
 - 2) Not easily bent if an attempt is made to close door without releasing door stop.
 - e. Window: Provide an ample sized, wired glass, gasketed observation window on each door to observe diode blown fuse indicators.

- f. Install front-mounted indicating and control devices without damaging the exposed finished surfaces.
 5. Lights: Provide inside equipment enclosures, as specified in Section 34 21 18, TES Lighting.
- D. Bus and Connections:
 1. Rectifier buses shall be made of rigid, high conductivity, electrical grade copper.
 2. Buses shall be suitably braced between each other and to the enclosure with high-strength, non-tracking porcelain or fiberglass insulators.
 3. Buses shall be braced to safely withstand the available short-circuit current without damage to the bus or the rectifier.
 4. Where aluminum heat sinks are bonded to a copper bus, coat connection with oxide inhibitor to prevent bimetallic corrosion.
 5. Bus connections shall be bolted using a minimum of four bolts per joint.
 - a. Wherever bolted together, the mating surfaces of copper buses shall be silver-plated.
 - b. Bolted connections shall be made with Belleville washers.
 6. Buses shall extend through the compartment walls to rear bus compartment and connected to the dc switchgear.
 7. Rectifier section shall be designed as an integral part of the dc switchgear line up and shall be insulated from the ac and dc switchgear, substation grounds, or other enclosures.
 8. Metal barriers, electrically bonded to the frame, shall be provided between dc positive and negative buses and terminal connections within the rectifier.
- E. Dc surge arrester:
 1. Rectifier unit shall be equipped with dc surge arresters.
 2. The arresters shall limit the reverse voltage across rectifier silicon diodes to a value less than 75 percent of the peak-reverse-voltage rating of the diode by limiting the rise of the transient on the positive to negative bus.
 3. Ensure that arresters will fail in a safe manner without damage to equipment and will self extinguish. Install in separate enclosure if necessary.
- F. Silicon Diodes:
 1. Silicon diodes shall be hermetically sealed and mounted on adequate heat sinks.
 2. Diodes shall be rated and tested in accordance with IEEE 1653.2 for extra heavy traction service.
 3. Rectifier shall be able to withstand a bolted fault on the dc switchgear bus without exceeding the safe diode junction temperature on the active diode for the time it takes the ac breaker to clear the fault.
 4. Each diode shall be capable of withstanding, at its maximum operating temperature during blocking periods, repetitive voltages having a value 250

- percent of its working peak reverse voltage without a permanent change in diode characteristics.
5. Each individual diode shall have a peak inverse voltage rating equal to at least 266 percent of the applied peak inverse voltage at no load.
 6. Parallel stacks of diodes, when used, shall be electrically and geometrically similar and as symmetrical as practical to help balance the normal and surge electrical characteristics of each.
 7. Design rectifier to maintain current balance between parallel-connected diodes, if used, in each phase.
 - a. The current for each diode of a parallel-connected stack shall not differ from its proportionate share of the total current by more than plus or minus 10 percent, between 50 percent and 150 percent of the rated capacity.
 - b. Current balancing shall not be achieved by use of selectively matched diodes.
- G. Fuses:
1. Provide one current limiting fuse in series with each phase.
 - a. Each fuse shall have adequate interrupting capacity
 - b. Provide a visual fuse failure indication.
 - c. Fuse failure indication shall be visible from outside rectifier through observation window.
 2. Size fuses to the diode current rating. Diodes shall not open or fail on an external dc fault or rated overload condition.
 - a. Only the fuse connected to a failed (shorted) diode shall open.
 - b. No other rectifier diodes or fuses shall fail or be damaged when one diode fails.
 3. Fuses: 750 V minimum, indicating type, affixed with micro switches for Device 98.
- H. Diode Failure:
1. Diode failure 1 (98R1): If one diode fails, or if one entire leg fails, send alarm to SAS.
 2. Diode failure 2 (98R2): If one leg has failed, and a second leg fails, trip the ac lockout relay (Device 86).
- I. Special Tools: Provide special tools to remove or install the diodes and/or diode fuses and/or hardware with each substation rectifier.
- J. Internal Wiring: 2 kV switchboard wire, per Section 34 22 10, TES Low-Voltage Conductors and Cable.
- K. Heating and Cooling System:
1. Auxiliary heating will be by a thermostatically-controlled space heater within the substation. Heaters mounted within the rectifier enclosure are not necessary.

2. Rectifier shall be natural convection air-cooled.
 - a. Circulation of ambient air shall do all necessary cooling at the IEEE 1653.2 extra heavy traction service loading specified.
 - b. Cooling ducts shall not be used.
 3. All rectifiers shall be equipped with fans and thermostats for future forced air cooling.
- L. Maintenance: Heat transfer surfaces and characteristics shall be designed for easy cleaning and to minimize accumulations of dust and other contaminants expected in the operating environment.
- M. In accordance with this Specification, voltages other than 125 Vdc control power are not permitted within the enclosure unless a specific requirement is stated in this Contract.
- N. Nameplate:
1. Provided each rectifier with a corrosion resistant metal nameplate containing the following information at a minimum:
 - a. Name of Manufacturer.
 - b. Descriptive Name.
 - c. Type Designation.
 - d. Serial Number(s).
 - e. Output Rated Power.
 - f. Output Rated Voltage.
 - g. Output Rated Current.
 - h. Overload Currents - Magnitude and Duration.
 - i. Weight.
 - j. Schematic Diagram Number.

2.5 RECTIFIER-TRANSFORMER

- A. Provide dry-type rectifier-transformer of VPI (Vacuum Pressure Impregnation).
- B. Ratings and Configuration:
1. Ventilated, self-cooled Class AA/FA.
 2. Transformer capacity shall be as required to achieve the specified transformer-rectifier unit rating.
 3. IEEE 1653.2 extra heavy traction service duty cycle.
 4. Transformer shall not suffer loss of life when operated at the specified duty cycle overload.
 5. Insulation Class: 220 degrees C class.

6. Temperature Rise: Limit winding hottest-spot temperature rise and average winding temperature rise to the values given in IEEE C57.12.01 for the specified insulation class.
 7. Cooling fans:
 - a. Provide fans for forced air cooling, controlled by transformer temperature monitor.
 - b. Fans shall increase the overall rating of rectifier-transformer by 33 percent of its rated output current without exceeding specified temperature rise.
 8. Select the transformer impedance to provide the rectifier output voltage specified.
- C. Windings:
1. Material: Copper.
 2. Windings shall not absorb moisture and shall be suitable for both storage and operation in adverse environments, including prolonged storage in 100 percent humidity at temperature from minus 30 degrees C to 40 degrees C.
 3. Primary windings mainline:
 - a. Delta-connected.
 - b. 95 kV BIL.
 4. Secondary windings mainline:
 - a. Connected for 12-pulse rectification.
 - b. 20 kV BIL
 5. Primary windings VMF:
 - a. Delta connected.
 - b. 20 kV BIL
 6. Secondary windings VMF:
 - a. Connected for 6-pulse rectification.
 - b. 20 kV BIL.
- D. Taps:
1. Provide full capacity taps on primary voltage windings:
 - a. Two above rated voltage in 1.25-percent steps;
 - b. Two below rated voltage in 2.5 percent steps;
 - c. One at rated voltage.
 - d. Taps to the nearest turn are acceptable if the exact percentage cannot be achieved.

2. Tap changing shall be by movable silver plated copper bus links for de-energized tap changing.
 3. Taps shall be brought out the side of the transformer, not the top.
 4. Insulate jumpers from the transformer taps to the tap changer board and primary bus and keep as short as possible so as not to interfere with access to the coils for maintenance.
 5. Tap connections shall be accessible through the front hinged enclosure doors.
 6. Identify tap connections so that the tap selected is clearly visible through the observation window.
 7. Securely bolt the tap-changing bus links in position.
 8. Design of links and connectors shall make it impossible to short out sections of windings, or to select taps outside the prescribed range, by incorrectly connecting the links.
- E. Connections:
1. Switchboard: Connect the high-voltage side using electrical grade copper bus with silver plated joints.
 2. Rectifier: Connect the low voltage side using electrical grade copper bus with silver plated joints.
- F. Bus supports:
1. Securely support bus from transformer frame using porcelain insulators.
 2. Size bus supports for mechanical strength and ability to withstand a bolted fault without distortion.
 3. Porcelain insulators: ASTM D116, rated for the line-to-line voltage application, free of imperfections. Insulators that have been re-touched with paint shall not be used.
- G. Bus Bars:
1. Size:
 - a. Minimum 1/4-inch by 2-inch, sized for mechanical strength and ability to withstand a bolted fault without distortion.
 - b. Size bus for a current density of 750 A per square inch, or a maximum temperature of 90 degrees C at a 40 degree C ambient, whichever results in a larger size.
 2. Bolted connections: Use a minimum of two silicon bronze bolted connections with Bellville washers on high and low voltage ac and dc buses.
- H. Conductors within Transformer Enclosure:
1. Conductors not connected to transformer primary or secondary:
 - a. Voltage rating: 600 V.
 - b. Temperature rating: 105 degrees C.

-
- c. Protection:
 - 1) Enclose in GRS conduit securely strapped to the transformer frame or base, or to the enclosure if conduit does not obstruct removable panels or doors.
 - 2) If conduit must be secured to both frame or base and enclosure, insert a short section of liquidtight flexible metallic conduit for vibration isolation.
 - 3) Conductors may be unprotected for a maximum of 8 inches at the point of connection.
 - 2. Cable jumpers from the secondary taps on the coil to the bus:
 - a. Sized for maximum loading for IEEE 1653.2 extra heavy traction service.
 - b. Temperature rating: 105 degrees C.
 - c. Voltage rating: 2 kV.
 - d. Insulation level: 133 percent.
 - I. Maintainability:
 - 1. Design transformer so that parts that require maintenance are readily accessible from the front and rear.
 - 2. Ensure that bottom and top of coils are readily accessible for cleaning without removing buswork, panels, or obstructions of any kind.
 - J. Transformer Enclosure and Base:
 - 1. Enclosure:
 - a. Enclose transformer in a rigid, self-supporting and self-contained, electrically welded or bolted, indoor, steel enclosure.
 - b. Enclosure shall not rely on transformer frame for support. Avoid attachments to transformer frame.
 - c. Vibration isolation: If enclosure is attached to transformer at any point, provide vibration isolation at attachment points.
 - 2. Front door:
 - a. The entire front of the transformer shall open by padlockable hinged double doors secured by three-point latches.
 - b. Window: Provide an ample sized, wired glass, gasketed observation window in the front hinged doors; position such that the tap connections are readily visible.
 - 3. Ventilation louvers: Design for maximum cooling from the bottom to top.
 - 4. Rear panels:
 - a. The rear of the transformer shall be accessible by removable panels with stainless steel handles and lifting means.

- b. Secure panels with 3/8-inch minimum stainless steel vandal-proof machine screws tapped into machined bosses.
5. Transformer base:
- a. Construct from structural steel members suitable for rolling or skidding in any direction.
 - b. Make provisions for pulling along the centerlines perpendicular to each side.
 - c. Provide jacking facilities at each of the four corners of the base to permit insertion of rollers between floor and base.
 - d. Base construction shall firmly secure the core to prevent relative motion of the core during shipment, handling, or seismic shock.
6. Transformer frame:
- a. Provide lifting hooks or eyes on the transformer frame with a safety factor of four to facilitate lifting the unit.
 - b. The structure shall be sufficiently rigid to withstand maximum transformer short circuit currents without deformation.
7. Transformer Mounting: Design to minimize vibration by using vibration isolation dampers.
8. Lights: Provide inside equipment enclosures, as specified in Section 34 21 14, TES Lighting.
9. Nameplate:
- a. Provide rectifier-transformer with a corrosion-resistant metal nameplate marked in accordance with IEEE C57.12.01.
 - b. Securely fasten to the front of the enclosure.
- K. Ac Surge Arrester:
- 1. Provide ac surge arresters on the rectifier-transformer primary side.
 - 2. Provide a separate compartment for ac surge arresters within transformer enclosure.
 - 3. Compartment shall be rigid steel, self-supporting and self-contained, electrically welded or bolted.

2.6 TRANSFORMER DESIGN OPTIMIZATION

- A. Optimize the transformer design and select appropriate materials to provide transformers with the lowest possible life cycle cost.
- 1. Definition of Life Cycle Cost: The sum of the cost of procurement and the cost of energy losses over the equipment's expected life.
 - 2. Calculate cost of energy losses over the transformer's expected life by:
 - a. First, calculating annual cost of transformer energy losses (see Table 1, below);

- b. Second, using the calculated annual cost of transformer energy losses to calculate the present worth of transformer energy losses over the 30-year expected life (see Table 2, below).

TABLE 1 – TRANSFORMER ENERGY LOSS SCHEDULE			
Column 1	Column 2	Column 3	Column 4
Transformer Load (as percentage of rated power)	Transformer Energy Losses (at Column 1 Loads) (kW)	Estimated Annual Hours (of operation at given loads) (Hours)	Annual Transformer Energy Losses (kWh)
0 percent			
20 percent			
60 percent			
100 percent			
150 percent			
220 percent			
300 percent			
Total Transformer Annual Energy Losses E_L (kWh)			

- B. Using Table 1 - Transformer Energy Loss Schedule:
 - 1. In Column 2, enter transformer energy losses in kW for each indicated transformer load in Column 1. Include energy losses in the transformer windings, steel core, and busbars, and demand requirements of auxiliary equipment such as cooling fans.
 - 2. In Column 4 calculate the Transformer Annual Energy Losses in kWh by multiplying the Transformer Energy Losses entered in Column 2 by the Estimated Annual Hours provided in Column 3.
 - 3. Total the numbers in Column 4 and enter in the box at the bottom of Table 1 for the Transformer Annual Energy Losses, E_L .
 - 4. Use this number to calculate the Present Worth of Transformer Energy Losses in Table 2.

TABLE 2 – PRESENT WORTH OF TRANSFORMER ENERGY LOSSES		
Equation:	$PW = N \cdot E_L \cdot e^{-[1/(1+i) + (1+k)/(1+i)^2 + \dots + (1+k)^{n-1}/(1+i)^n]}$	
SYMBOL	DESCRIPTION	VALUE
PW	Present worth of transformer energy losses (Dollars)	\$ _____
N	Number of transformer units	5 (mainline only)
E_L	Transformer annual energy losses (kWh)	from Table 1
E	Utility energy rate (Dollars/kWh)	0.09
i	Interest rate	0.04 (4 percent)
k	Average energy cost escalation factor	0.04
n	Transformer expected life (years)	30

- C. Using Table 2 - Present Worth of Transformer Energy Losses:
1. Calculate the Present Worth of Energy Losses, PW, in dollars over a 30-year period using the equation and values in Table 2.
 2. Insert the calculated Present Worth of Transformer Energy Losses into the Request for Proposal Bid List, where indicated.
- D. Measured Present Worth of Transformer Energy Losses:
1. After transformer is manufactured, measure the actual losses for the transformer at the load levels specified in Table 1.
 2. Update Table 1 with the measured values and recalculate Transformer Annual Energy Losses.
 3. Calculate the Present Worth of Transformer Energy Losses using Table 2, with the new value of Transformer Annual Energy Losses based on measured values.
- E. Comparison of Calculated and Measured Present Worth of Transformer Energy Losses:
1. Compare the Calculated Present Worth of Transformer Energy Losses (entered on the Price Page) with the Measured Present Worth of Transformer Energy Losses (calculated using measured values of a transformer manufactured for this project).
 2. If the Measured Present Worth of Transformer Energy Losses exceeds the Calculated Present Worth of Transformer Energy Losses, the Engineer will issue a unilateral deductive Change Order to deduct the dollar value of the difference between the two.
 3. If the Measured Present Worth of Transformer Energy Losses is equal to or less than the Calculated Present Worth of Transformer Energy Losses, no action will be taken.

2.7 INTERPHASE TRANSFORMER

- A. Design interphase transformer in coordination with transformer-rectifier unit to meet the specified voltage regulation and maximize efficiency, under Kansas City service conditions.
- B. Design, submit product data and shop drawings, and test in accordance with IEEE 1653.2.

2.8 FACTORY ASSEMBLY

- A. Completely insulate rectifier from ground and from the rectifier-transformer and the ac switchgear.
 - 1. Insulate and isolate rectifier from the floor using an epoxy floor covering in accordance with Section 34 21 08, TES Dielectric Epoxy Flooring.
 - 2. Insulate and isolate rectifier from the transformer using electrical laminate in accordance with Section 34 21 17, TES Substation Design and Assembly.

2.9 SOURCE QUALITY CONTROL

- A. Factory Design Tests:
 - 1. Transformer-Rectifier Unit Test:
 - a. General Requirements:
 - 1) Existing test reports will not be accepted in lieu of this test.
 - 2) Transformer-rectifier unit shall be tested as a complete assembly including interconnecting bus and enclosures. Ac switchgear is a required part of the assembly only for the short circuit test. Dc switchgear is not required.
 - b. Short circuit test:
 - 1) Conduct at a certified laboratory.
 - 2) Power supply shall be minimum 10 MVA.
 - 3) Transformer taps on high-voltage windings shall be connected at the center position of the five available taps.
 - 4) Set ac breaker for the IEEE 1653.2 short-time overload for extra heavy traction service.
 - 5) Perform in accordance with IEEE C57.12.91, to fully evaluate the capability of all windings.
 - a) Apply fault on the rectifier secondary.
 - b) Make recommended terminal measurements.
 - c. Rated current test:
 - 1) Perform in accordance with IEEE 1653.2.
 - 2) Thermocouple locations shall be indicated in test procedure and approved by the Engineer.
 - 3) Transformer temperature rise determined by any of the thermocouples shall not exceed specified values.
 - 4) Verify efficiency, voltage regulation, and power factor at loads shown in IEEE 1653.2 for extra heavy traction service.

-
- d. Audible sound level test:
 - 1) Perform audible sound level tests in accordance with IEEE C57.12.91 using A-weighting, except apply 3-foot distance.
 - 2) Maximum sound level shall not exceed 60 dBA at 100 percent load measured 3 feet away from assembly.
 - 3) For 12-pulse Circuit 31 rectifier-transformers, include interphase transformer in transformer-rectifier assembly.
 - 4) Measure sound level with rectifier-transformer in its enclosure with all panels bolted closed.

 - 2. Rectifier:
 - a. Dielectric tests: In accordance with IEEE 1653.2.
 - b. Rated voltage test: Subject rectifier to 110 percent of ac rated voltage for 5 minutes with the dc circuit open.
 - c. Current unbalance test:
 - 1) In accordance with IEEE 1653.2.
 - 2) Test may be performed during the design test for transformer-rectifier unit.
 - d. Loss measurement test: Comply with IEEE 1653.2.
 - e. Rated current test:
 - 1) At reduced voltage.
 - 2) After temperature stabilization at rated load.
 - 3) Include the overloads outlined in IEEE 1653.2.
 - 4) Perform with one diode removed from each phase arm. Engineer to select diodes to be removed for test.
 - 5) Shall demonstrate that the maximum safe junction temperature for each diode is not exceeded.
 - 6) Verify efficiency, voltage regulation, and power factor at loads shown in IEEE 1653.2 for extra heavy traction service.

 - 3. Rectifier-transformer:
 - a. Resistance measurements: Take in accordance with IEEE C57.12.91 except that they shall be taken for all tap settings.
 - b. Impedance and load loss: Perform tests in accordance with IEEE C57.18.10 except perform on all windings on all tap settings.
 - c. Commutating reactance: Calculate from load loss tests in accordance with IEEE C57.18.10.

- d. Impulse test:
 - 1) Perform in accordance with IEEE C57.12.91.
 - 2) Perform after completion of short circuit tests.
 - e. Temperature rise tests: Perform in accordance with IEEE C57.12.91 for extra heavy traction service.
 - f. Partial discharge test: Perform after completion of all other tests.
 - g. Engineer shall be the sole judge of the serviceability of transformer after completion of design testing.
- B. Factory Production Tests:
- 1. Rectifier:
 - a. Dielectric tests: Perform in accordance with IEEE 1653.2.
 - b. Continuity tests: Perform for all cables and buses.
 - c. Rated voltage test: Perform in accordance with IEEE 1653.2.
 - 2. Rectifier-transformer:
 - a. Dielectric tests: Perform in accordance with IEEE C57.12.91.
 - b. Applied-voltage test: Perform in accordance with IEEE C57.12.91.
 - c. Induced-voltage tests: Perform in accordance with IEEE C57.12.91.
 - d. Resistance measurements: Take for all windings on all taps.
 - e. Ratio tests: Perform on the rated voltage connections and on all taps in accordance with IEEE C57.12.91.
 - f. Polarity and phase relation tests: Perform in accordance with IEEE C57.12.91.
 - g. No-load losses and excitation current: Determine in accordance with IEEE C57.12.91.
 - h. Partial discharge test:
 - 1) Subject transformer to an induced voltage of 1.5 times the rated voltage at a frequency between 100 and 400 Hz.
 - 2) Partial discharge extinction level shall be reached at an induced voltage of not less than 1.2 times the rated line-to-line voltage.
 - 3) Partial discharge extinction level will be defined as the point when the reading at 1.9 MHz is less than 10 microvolts or 13 picocoulombs.

PART 3 - EXECUTION**3.1 INSTALLATION**

- A. Insulate rectifier in built-in-place substation as required in Part 2, above, in the article titled "Factory Assembly."

PART 4 - MEASUREMENT AND PAYMENT**4.1 MEASUREMENT**

- A. The quantities of accepted work will be measured in the following units. All measurements will be plan measure except for authorized changes.
 - 1. Description: Lump Sum

4.2 PAYMENT

- A. Payment will be made at the respective unit or lump-sum price listed in the proposal and shall be full compensation for all labor, materials, and equipment necessary to complete the respective unit in place. There will be no separate measurement or payment for any item of work not specifically identified and listed in the proposal, and all such work shall be considered a subsidiary item with all costs pertaining thereto included in the prices for other items listed in the proposal. At the Engineer's option, partial payment may be made for any lump sum item listed in the proposal, providing that the Contractor is diligently and satisfactorily pursuing full completion of such partially complete item in accordance with the approved job progress schedule.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 34 21 24**TES DRY TYPE TRANSFORMERS****PART 1 - GENERAL****1.1 SUMMARY**

- A. This Section includes low voltage two-winding dry-type transformers.
- B. Refer to Section SECTION 34 21 23 – TES Transformer-Rectifier Unit for rectifier transformer requirements.

1.2 RELATED SECTIONS

- A. SECTION 01 33 00 – Submittal Procedures
- B. SECTION 34 21 05 – Common Work Results for TES
- C. SECTION 34 21 06 – TES Common Work Results for Metals
- D. SECTION 34 21 14 – TES Medium-Voltage Ac Switchgear
- E. SECTION 34 21 23 – TES Transformer-Rectifier Unit
- F. SECTION 34 21 80 – TES Spare Parts and Special Tools

1.3 REFERENCED STANDARDS

- A. Section incorporates by reference the latest revisions of the following documents:
- B. Institute of Electrical and Electronics Engineers (IEEE):
 - 1. IEEE C57.12.01, General Requirements for Dry-Type Distribution and Power Transformers Including Those with Solid-Cast and/or Resin Encapsulated Windings
 - 2. IEEE C57.12.91, Standard Test Code for Dry-Type Distribution and Power Transformers
- C. National Electrical Manufacturer's Association (NEMA):
 - 1. NEMA 250, Enclosures for Electrical Equipment (1000 Volts Maximum)
 - 2. NEMA TP 1, Guide for Determining Energy Efficiency for Distribution Transformers
- D. National Fire Protection Association (NFPA)
 - 1. NFPA 70, National Electrical Code (with amendments by the Authority Having Jurisdiction)

1.4 SUBMITTALS

- A. Procedures: SECTION 01 33 00 – Submittal Procedures.

- B. Product Data: Submit manufacturer's product data of manufactured materials and equipment including the following:
 - 1. Outline and support point dimensions of enclosures and accessories.
 - 2. Unit weights.
 - 3. Voltage, kVA and impedance ratings and characteristics.
 - 4. Loss data.
 - 5. Efficiency at 25, 50, 75 and 100 percent rated load.
 - 6. Sound level.
 - 7. Tap configuration.
 - 8. Insulation system type and rated temperature rise.
- C. Spare Parts and Special Tools:
 - 1. Submit a list of spare parts to be provided under this Section.
 - 2. Submit at the same time as product data.
 - 3. Provide part numbers for each part, including a detailed break down of each spare part assembly and set, as defined in SECTION 34 21 80 – TES Spare Parts and Special Tools.
- D. Sizing Calculations: Submit calculations for sizing of the Station Service Transformer. Allow for 20 percent additional future load. At a minimum, the transformer shall be rated 25 kVA.
- E. Operation and Maintenance Data:
 - 1. Submit manufacturer's operating and maintenance instructions on products specified in this Section.
 - 2. Submit immediately after approval of product data.

1.5 SPARE PARTS

- A. Submit spare parts in accordance with SECTION 34 21 80 – TES Spare Parts and Special Tools.
- B. List below applies to items in this Specification Section:
 - 1. Station service transformer: Provide 1 spare of each size.

PART 2 - PRODUCTS

2.1 DRY TYPE TWO-WINDING TRANSFORMERS

- A. Dry Type Transformers: IEEE C57.12.01; factory-assembled, air cooled dry type transformers; ratings as shown on Contract Drawings.
- B. Insulation system and average winding temperature rise for rated kVA as follows:
 - 1. 1 to 15 kVA: Class 185 insulation, 80 degrees C rise.

-
2. 16 to 500 kVA: Class 220 insulation, 115 degrees C rise.
- C. Load Ratings and Transformer Cooling: Load ratings, unless noted otherwise, are assumed to be AA (air convection cooling).
 - D. Windings: Copper primary and secondary.
 - E. Winding Taps:
 1. Transformers Less than 15 kVA: Two 5 percent, full-capacity taps below rated voltage on primary winding.
 2. Transformers larger than 15 kVA and smaller than 500 kVA: Two 2.5 percent full-capacity taps above rated voltage and four 2.5 percent full-capacity taps below rated voltage on primary windings.
 - F. Energy Efficiency: NEMA TP 1.
 - G. Sound Levels: Shall not exceed the following when tested according to IEEE C57.12.91.
 1. 10 to 50 kVA: 45 dB.
 2. 51 to 150 kVA: 50 dB.
 3. 151-300 kVA: 55 dB.
 4. 301 to 500 kVA: 60 dB.
 - H. Basic Impulse Level:
 1. Low-Voltage Dry-Type Transformers:
 - a. Transformers less than 300 kVA: 10 kV.
 - b. Transformers 300 kVA and larger: 30 kV.
 2. Medium-Voltage Dry-Type Transformers: 95 kV.
 - I. Ground core and coil assembly to enclosure by means of a visible, flexible copper grounding strap.
 - J. Mounting:
 1. 75 kVA and less: Suitable for wall, floor, or trapeze mounting, or mounting internal to switchgear.
 2. Larger than 75 kVA: Suitable for floor or trapeze mounting.
 - K. Coil Conductors: Continuous windings with terminations brazed or welded.
 - L. Enclosure:
 1. Construction: Heavy gage sheet steel, ventilated.
 2. Type:
 - a. Indoor: NEMA 250 Type 1.
 - b. Outdoor: NEMA 250 Type 3R.

3. Finish: Powder coat complying with Section 34 21 06, TES Common Work Results for Metals.
 4. Standards compliance: NEMA 250, NFPA 70, IEEE C57.12.01.
 5. Enclosure requirements do not apply to transformer located within ac switchgear cubicle, as indicated on Contract Drawings
- M. Isolate core and coil from enclosure using vibration-absorbing mounts.
- N. Nameplate: Include transformer connection data.

2.2 STATION SERVICE TRANSFORMER

- A. Calculate size of the Station Service Transformer as follows:
1. Calculate load per NFPA 70 based on heating, cooling, lighting, and other loads.
 2. Allow for 20 percent additional future load.
 3. At a minimum, the transformer shall be rated 25 kVA.
 4. Provide primary fused disconnect and secondary circuit breaker complying with NFPA 70.

2.3 FACTORY ASSEMBLY

- A. Install transformers plumb and level.
- B. Use copper bus for both primary and secondary connections.
- C. Mount transformers inside substation on vibration isolating pads suitable for isolating the transformer noise from the structure.
- D. Provide restraints for vertical and horizontal seismic motion in accordance with the seismic requirements in Section 34 21 05, Common Work Results for TES.
- E. Station Service Transformer: Mount inside ac switchgear enclosure, as described in Section 34 21 14, TES Medium-Voltage Ac Switchgear. No station service transformers are required for built-in-place substation.

PART 3 - EXECUTION

3.1 FIELD INSTALLATION

- A. Requirements of Article titled "Factory Assembly" apply to field installation.

3.2 FIELD QUALITY CONTROL

- A. Check for damage and tight connections before energizing transformer.
- B. Measure primary and secondary voltages and make appropriate tap adjustments.

PART 4 - MEASUREMENT AND PAYMENT**4.1 MEASUREMENT**

A. The quantities of accepted work will be measured in the following units. All measurements will be plan measure except for authorized changes.

1. Description: Lump Sum

4.2 PAYMENT

A. Payment will be made at the respective unit or lump-sum price listed in the proposal and shall be full compensation for all labor, materials, and equipment necessary to complete the respective unit in place. There will be no separate measurement or payment for any item of work not specifically identified and listed in the proposal, and all such work shall be considered a subsidiary item with all costs pertaining thereto included in the prices for other items listed in the proposal. At the Engineer's option, partial payment may be made for any lump sum item listed in the proposal, providing that the Contractor is diligently and satisfactorily pursuing full completion of such partially complete item in accordance with the approved job progress schedule.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 34 21 25

TES DC CONTROL POWER

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Battery charger/eliminator and batteries.
 - 2. Enclosed low-voltage switches and fuses.
 - 3. Dc distribution panelboard circuit breakers.
 - 4. Dc control circuit overcurrent protection.
 - 5. Low voltage dc power supply.

1.2 RELATED SECTIONS

- A. SECTION 01 33 00 – Submittal Procedures
- B. SECTION 34 21 12 – TES Low-Voltage Panelboards
- C. SECTION 34 21 17 – TES Substation Design and Assembly
- D. SECTION 34 21 31 – TES Substation Automation System (SAS)
- E. SECTION 34 21 80 – TES Spare Parts and Special Tools
- F. SECTION 34 21 90 – TES Testing

1.3 REFERENCED STANDARDS

- A. Section incorporates by reference the latest revisions of the following documents:
- B. Institute of Electrical and Electronics Engineers (IEEE)
 - 1. IEEE 485, Recommended Practice for Sizing Lead Acid Batteries for Stationary Applications
- C. National Electrical Manufacturers Association (NEMA)
 - 1. NEMA FU 1, Low Voltage Cartridge Fuses
 - 2. NEMA KS 1, Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)
 - 3. NEMA 250, Enclosures for Electrical Equipment (1000 Volts Maximum)
 - 4. NEMA PE 5, Utility Type Battery Chargers
- D. Underwriters Laboratories (UL)
 - 1. UL 489, Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures

1.4 SUBMITTALS

- A. Procedures: SECTION 01 33 00 – Submittal Procedures.
- B. Product Data:
 - 1. Submit manufacturers' product data for specified equipment and materials.
- C. Spare Parts and Special Tools:
 - 1. Submit a list of spare parts to be provided under this Section.
 - 2. Submit at the same time as product data.
 - 3. Provide part numbers for each part, including a detailed break down of each spare part assembly and set, as defined in SECTION 34 21 80 – TES Spare Parts and Special Tools .
 - 4. Submit a list of special tools to be provided under this Section. List requirements are defined in SECTION 34 21 80 – TES Spare Parts and Special Tools and required special tools are described below in Part 2.
- D. Calculations:
 - 1. Battery capacity calculations, including load calculations.
- E. Testing:
 - 1. Submit test procedures that meet the requirements of SECTION 34 21 90 – TES Testing for the following:
 - a. Factory Design Tests.
 - 2. Submit test reports that meet the requirements of Section SECTION 34 21 90 – TES Testing, for the following:
 - a. Factory Design Tests.
- F. Operations and Maintenance Data:
 - 1. Submit manufacturer's operating and maintenance instructions on products specified in this Section.
 - 2. Submit immediately after approval of product data.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Spare Parts:
 - 1. Deliver spare parts in accordance with SECTION 34 21 80 – TES Spare Parts and Special Tools.
 - 2. Furnish the following items specified in this Section:
 - a. Battery cells: Provide 4 spares of each type.
 - b. Battery charger/eliminator: Provide 1 spare.
 - c. Mini circuit breakers: Provide 2 spare sets.

- d. Low voltage dc power supply: Provide 2 spares each type.
- B. Special Tools and Accessories: Submit product data and provide the following accessories for normal operation and maintenance:
 - 1. Cell lifting sling complete with strap and spreader bar.
 - 2. Battery log book.
 - 3. Quart of terminal grease, if recommended.
 - 4. Set of special tools for maintenance.
 - 5. Micro ohmmeter for testing battery connection resistance.
 - 6. Set of cell identification numbers.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Ship batteries separate from substation.

1.7 WARRANTY

- A. Batteries: Furnish warranty of one (1) year from the date of the battery is placed in service and additional warranty of 9 years, pro rata, to deliver not less than 90% of its rated capacity.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Batteries and associated charger/eliminators shall operate in parallel, with the charger charging the battery while supplying the continuous connected loads.
- B. Batteries shall supply peak short time current demands and, when the ac supply to the charger is interrupted, supply the entire connected load.
- C. Batteries and charger/eliminators shall be rated for operation within the temperature range specified in SECTION 34 21 31 – TES Substation Automation System (SAS), and shall be capable of operation up to 100 degrees F.
- D. After a continuous 10 hours of battery charger outage, trip and lockout the high-voltage ac circuit breaker, via the 86H relay and trip and lockout the dc circuit breakers via the 186H relays.

2.2 BATTERY CHARGER/ELIMINATOR

- A. Charger/eliminators: Solid-state, constant voltage, automatic, fully regulated, with output voltage temperature compensation, silicon controlled rectifier, convection cooled, complying with NEMA PE 5. Provide battery charger/eliminators to meet the following requirements:
 - 1. Rated for continuous operation, float-charging the battery, and for recharging the battery from a cell voltage of 1.1 V to 85 percent of battery capacity in a maximum of 8 hours, while simultaneously supplying the load demands.
 - 2. Input voltage Rating:
 - a. Mainline: 240 Vac, 60 Hz, single phase.

- b. VMF: 208/120 Vac, 60 Hz, single phase.
 3. Output voltage and current: Matched to the requirements of the battery and the load.
 4. Output voltage regulation: Plus or minus 0.25 percent of output voltage over its complete load range with a plus or minus 10 percent variation of input ac voltage. Output ripple shall not exceed 30 mV rms.
 5. Output current limiting: Adjustable from 90 percent to 115 percent of output nominal current rating, and factory set at 110 percent.
 6. Filtered output to maintain ripple within the specified limits when the battery is disconnected.
 7. Adjustable 0 to 72 hour equalizing time charger, manually set for supplying an equalizing voltage per cell as recommended by battery manufacturer.
 8. Ac Input and Dc Output circuit breakers: Molded-case type complying with the requirements in UL 489.
 9. Enclosures: NEMA 250, Type 12 with hinged covers, lockable handles and two point (minimum) latches.
- B. Provide the following additional features/options:
1. Dc voltmeter with 0 V to 200 V range.
 2. Dc ammeter
 3. Ac input pilot light marked "AC POWER ON."
 4. Two-position selector switch marked "FLOAT" and "EQUALIZE."
 5. Output ground fault pilot lights for positive and negative poles.
 6. Input line surge and transient-protective devices.
 7. Battery charger failed alarm.
 8. Battery undervoltage alarm.
 9. Battery overvoltage alarm.
 10. Ground fault alarm.
- C. Send alarms to SAS, as specified in SECTION 34 21 31 – TES Substation Automation System (SAS).

2.3 BATTERIES

- A. Batteries shall be designed specifically for float application and shall be sized for the specified duty cycle.
1. Type: Heavy-duty, valve regulated, lead acid, absorbed glass mat.
 2. Venting:
 - a. Batteries shall not vent gas under normal operation.

-
- b. Provide one-way self-resealing, safety pressure-relief valves.
3. Battery containers:
- a. Plastic, heat-resistant, flame retardant, impact resistant.
 - b. Covers shall be cemented in place to provide a permanent leak-proof seal.
 - c. Effectively seal at cell terminal posts with non-corrosive material.
 - d. Clearly and permanently mark polarity of cell terminal posts.
- B. Ratings:
- 1. Ampere-hour capacity: Select in accordance with IEEE 485 taking into account the calculated loads from all devices, as indicated on the Contract Drawings, for a 10-hour discharge rate to a final cell voltage of 1.75 V for the specified duty cycle.
 - 2. Battery duty cycle:
 - a. Duration: Period of 10 hours with the battery charger/eliminator out of service, assuming batteries are in a fully charged state at the beginning of the 10 hours.
 - b. Load:
 - 1) Normal continuous demand of the substation auxiliary loads, including relays, indicating lamps, dc-connected lights, and alarm panel.
 - 2) Trip and reclose cycle of one dc feeder breaker every hour.
 - 3) Trip and reclose of the ac breaker after two hours and again after eight hours.
- C. Lockout: Provide a timer such that after a continuous 10 hours of battery charger outage, timer shall trip and lockout the main ac circuit breaker via the 86 relay and trip and lockout the dc circuit breakers via the 186 relays.
- D. Connections:
- 1. Provide inter-cell connector buses.
 - 2. Provide nickel plated solid copper terminal plates, connectors, plates, and lugs.
- E. Battery Racks:
- 1. Provide a four tier structural steel battery support racks sized to allow 1/2 inch between batteries.
 - 2. Include insulating plastic strips to cover all supports, hold downs, and restraining rails that are in contact with cells.
 - 3. Finish with a caustic-resistant paint coat.
- F. Provide an insulating, electrolyte-resistant, plastic mat under each battery rack, extending a minimum of 12 inches outside the rack.

- G. Battery Rack Top:
 - 1. Clear polycarbonate, minimum 1/4 inch thick, with sharp edges removed.
 - 2. Dimensions: Minimum overall 1 inch longer and wider than battery rack length and width.
- H. Provide battery bank with a stainless steel nameplate. Nameplate shall be attached to the battery rack using stainless steel rivets and marked with the following information:
 - 1. Manufacturer's name.
 - 2. Month and year of manufacture.
 - 3. Battery and cell type.
 - 4. Ampere rating: 1 minute, 1 hour, and 5 hour.

2.4 FUSED DISCONNECT SWITCH

- A. Provide NEMA 250 Type 12, 2-pole, fused disconnect switch for isolation of the battery with the following requirements:
 - 1. Rating: 250 Vdc, current rating to match batteries.
 - 2. NEMA KS 1: Quick-make, quick-break, load interrupter enclosed knife switch with externally operable handle interlocked to prevent opening front cover with switch in ON position.
 - 3. Handle lockable in OFF position.
- B. Fuse Clips: Suitable for Class R or J fuses with fuse rejection devices installed.
- C. Fuses: NEMA FU 1 rated to provide short circuit protection for the battery and battery cables.
- D. Coordinate fuse and switch ratings with the output circuit breaker in the battery charger.
- E. Install disconnect switches where indicated on Contract Drawings or required by Codes with external handle centered 60 inches above finished floor or grade level.
- F. Install fuse-rejection devices in fuse clips if required.
- G. Install fuses in fusible disconnect switches.

2.5 DC DISTRIBUTION PANELBOARDS

- A. Comply with requirements of SECTION 34 21 12 – TES Low-Voltage Panelboards.
- B. Circuit breakers: 125 Vdc, 2-pole.

2.6 DC CONTROL CIRCUIT PROTECTION AND ALARMS

- A. Within switchgear, dc control circuits shall be protected by mini circuit breakers. Fuses shall not be used.
- B. Mini circuit breakers: 125 Vdc, 1-pole.

- C. Provide an undervoltage alarm (Device 127) for each dc control circuit.
 - 1. If a circuit from the dc distribution panelboard feeds downstream mini circuit breakers, each of those circuits controlled by a mini circuit breaker is considered a control circuit for the purposes of this requirement.
 - 2. Provide alarm to SAS; see SECTION 34 21 31 – TES Substation Automation System (SAS).

2.7 LOW-VOLTAGE DC POWER SUPPLY

- A. Voltage: 24 V or 48 V, but not both.
- B. Power supply shall be powered from TES substation 125 Vdc power source. Power supply shall be redundant:
 - 1. Provide a main low-voltage power supply with automatic transfer to a backup low-voltage power supply, or operate two low-voltage power supplies in parallel.
 - 2. Provide two circuits, each one fed from its own breaker in the 125 Vdc distribution panelboard, to power the two low-voltage power supplies.

2.8 FACTORY ASSEMBLY

- A. Install charger, battery rack, and other specified equipment within each substation enclosure secure, plumb and level and in true alignment with related adjoining work.
- B. Install supporting members, fastenings, framing, hangers, bracing, brackets, straps, bolts, and angles as required to set and rigidly connect the Work.
- C. Temporarily install batteries to conduct factory testing, then remove before shipping.
- D. Anti-oxidants and other solvents that can cause cracking of cell jars shall not be used on batteries.
- E. Verify that float and recharging rates are set to the values recommended by battery manufacturer.

2.9 SOURCE QUALITY CONTROL

- A. Factory Design Tests:
 - 1. Battery Charger: Tests shall comply with design tests described in NEMA PE 5.
- B. Factory Production Tests:
 - 1. Test the following:
 - a. Cell voltages.
 - b. Pressure-relief vent operation and reseal.
 - c. Cell jar leakage.

PART 3 - EXECUTION

3.1 FIELD INSTALLATION

- A. Requirements of Article titled "Factory Assembly" apply to field installation.
- B. Following installation of each prefabricated substation at site, install battery cells on battery racks in accordance with manufacturer's recommendations. Verify that there is minimum 1/2 inch between each battery and adjacent batteries.
- C. Install specified battery rack top after installing battery cells. Secure to top of rack posts.
- D. After battery installation provide an equalizing charge as recommended by battery manufacturer.
- E. Mount battery rack and batteries per seismic requirements.

3.2 FIELD QUALITY CONTROL

- A. Test function of batteries and charging system and test terminal connection resistance after delivery of prefabricated substations and installation of built-in-place substation in conformance with SECTION 34 21 90 – TES Testing.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

- A. The quantities of accepted work will be measured in the following units. All measurements will be plan measure except for authorized changes.
 - 1. Description: Lump Sum

4.2 PAYMENT

- A. Payment will be made at the respective unit or lump-sum price listed in the proposal and shall be full compensation for all labor, materials, and equipment necessary to complete the respective unit in place. There will be no separate measurement or payment for any item of work not specifically identified and listed in the proposal, and all such work shall be considered a subsidiary item with all costs pertaining thereto included in the prices for other items listed in the proposal. At the Engineer's option, partial payment may be made for any lump sum item listed in the proposal, providing that the Contractor is diligently and satisfactorily pursuing full completion of such partially complete item in accordance with the approved job progress schedule.

END OF SECTION

SECTION 34 21 31**TES SUBSTATION AUTOMATION SYSTEM (SAS)****PART 1 - GENERAL****1.1 SUMMARY**

- A. This Section includes SAS in TES substations including the following:
 - 1. Programmable Automation Controller (PAC).
 - 2. Human Machine Interface (HMI) Display.
 - 3. Industrial Ethernet switch.
 - 4. HMI design and software applications.
 - 5. SAS/SCADA points list.
 - 6. Local Wide Area Network (LWAN) for transfer trip between substations.

1.2 RELATED SECTIONS

- A. SECTION 01 33 00 – Submittal Procedures
- B. SECTION 34 21 17 – TES Substation Design and Assembly
- C. SECTION 34 22 15 – TES Fiber Optic Cable
- D. SECTION 34 21 25 – TES DC Control Power
- E. SECTION 34 21 80 – TES Spare Parts and Special Tools
- F. SECTION 34 21 90 – TES Testing
- G. SECTION 34 22 10 – TES Low Voltage Conductors and Cable
- H. SECTION 34 22 15 – TES Fiber Optic Cable

1.3 ABBREVIATIONS

- A. CPU Central Processing Unit
- B. DNP3 Distributed Network Protocol
- C. DVI Digital Visual Interface
- D. GPS Global Positioning System
- E. HDMI High Definition Multimedia Interface
- F. HMI Human Machine Interface
- G. IED Intelligent Electronic Device
- H. I/O Input/Output

I.	LAN	Local Area Network
J.	LWAN	Local Wide Area Network
K.	MAC	Media Access Control
L.	NTP	Network Time Protocol
M.	PAC	Programmable Automation Controller
N.	QoS	Quality of Service
O.	SAS	Substation Automation System
P.	SCADA	Supervisory Control and Data Acquisition
Q.	SFP	Small Form-factor Pluggable
R.	SNTP	Simple Network Time Protocol
S.	SSD	Solid State Drive
T.	TFT	Thin Film Transistor
U.	TCP/IP	Transmission Control Protocol/Internet Protocol
V.	TRAIM	Time-Receiver Autonomous Integrity Monitoring
W.	USB	Universal Serial Bus
X.	VGA	Video Graphics Array
Y.	VLAN	Virtual Local Area Network

1.4 DEFINITIONS:

- A. Intelligent Electronic Device (IED): See definition in SECTION 34 21 17 – TES Substation Design and Assembly.
- B. SAS: A network of PACs and IEDs in the substation operating as a system for control and monitoring of substation equipment.
- C. Supervisory Control and Data Acquisition (SCADA): An industrial control system consisting of SASs and other equipment controlled and monitored by a host workstation, or "Central Control".
- D. Failure: When an SAS component does not operate as designed.
- E. Repeated failure: Two or more failures of the same component; whether IED, communications interface hardware, related hardware, or software.

1.5 REFERENCED STANDARDS

- A. Section incorporates by reference the latest revisions of the following documents, or if standard is adopted by Kansas City, the latest revision adopted:
 - B. Code of Federal Regulations (CFR)
 - 1. CFR Title 47 Part 15, Radio Frequency Devices

- C. Institute of Electrical and Electronics Engineers (IEEE)
 - 1. IEEE C37.90, Standard for Relays and Relay Systems Associated with Electric Power Apparatus
 - 2. IEEE C37.90.2, Standard for Withstand Capability of Relay Systems to Radiated Electromagnetic Interference from Transceivers
 - 3. IEEE 730, Standard for Software Quality Assurance Plans
- D. International Electrotechnical Commission (IEC)
 - 1. IEC 60529, Degrees of protection provided by enclosures (IP Code)
 - 2. IEC 60255-21, Electrical Relays - Part 21: Vibration, shock, bump and seismic tests on measuring relays and protection equipment
 - 3. IEC 61000-4, Electromagnetic compatibility (EMC)
 - 4. IEC 61131-2, Programmable Controllers - Part 2: Equipment Requirements and Tests
 - 5. IEC 61131-3, Programmable Controllers - Part 3: Programming Languages
- E. International Organization for Standardization (ISO)
 - 1. ISO 9001, Quality Management Systems - Requirements
- F. National Fire Protection Association (NFPA)
 - 1. NFPA 70, National Electrical Code
- G. Underwriters Laboratories (UL)
 - 1. UL 60950-1, Information Technology Equipment – Safety – Part 1: General Requirements

1.6 SUBMITTALS

- A. Procedures: SECTION 01 33 00 – Submittal Procedures.
- B. Design Submittals:
 - 1. A written document describing the design, method of communication, and implementation of the selected communications protocol for the SAS and related components.
 - 2. Detailed design of the SAS and related components. Refer to Shop Drawings, below.
 - 3. Submit full-scale color screen shots of SAS applications displayed on the Human Machine Interface (HMI).
 - 4. Provide documentation demonstrating that specified requirements for service proven design have been met. Include contact information for transit agencies where units are in service.

-
- C. Product Data: Include technical details and operating manuals of the system and subsystems including hardware, software, MTBF information, communications protocol specifications and show compliance with the specified requirements.
1. PACs.
 2. HMI/Industrial Computer.
 3. Input/Output (I/O) modules
 4. Ethernet switches.
 5. Media converters.
 6. Network cables.
 7. HMI Development Software.
 8. Time server and GPS antenna.
 9. Laptop computer.
- D. Spare Parts and Special Tools List:
1. Submit a list of spare parts to be provided under this Section.
 2. Submit at the same time as product data.
 3. Furnish part numbers for each part, including a detailed break down of each spare part assembly and set, as defined in SECTION 34 21 80 – TES Spare Parts and Special Tools.
 4. Submit a list of special tools to be provided under this Section, as defined in SECTION 34 21 80 – TES Spare Parts and Special Tools.
- E. Shop Drawings:
1. Block diagrams
 2. Input/output maps
 3. Equipment layout drawings
 4. Ladder logic diagrams
 5. Wiring schematic
 6. Bill of Materials
- F. Software:
1. Provide development software for the SAS, including any software required to program, maintain, and download events/records for the PACs and HMI.
 2. Provide source code developed for the PACs and HMI in electronic format as directed by the Engineer.
 3. Furnish software licenses for application, interface, development software, and all other software, as described in Software Intellectual Property Rights Section below.

- G. Testing:
1. Submit test procedures that meet the requirements of SECTION 34 21 90 – TES Testing, for the following:
 - a. Factory Design Tests.
 - b. Operational Tests.
 2. Submit test reports that meet the requirements of SECTION 34 21 90 – TES Testing, for the following:
 - a. Factory Design Tests.
 - b. Operational Tests.
- H. System Support Plan for support during commissioning and warranty period.
- I. Operations and Maintenance Data:
1. Submit manufacturer's operating and maintenance instructions on products specified in this Section, including the following:
 - a. Submittal information identified above.
 - b. Manufacturer's operating and maintenance instructions, parts list, illustrations and diagram for components.
 2. Submit immediately after approval of product data.

1.7 SPARE PARTS

- A. Deliver spare parts in accordance with SECTION 34 21 80 – TES Spare Parts and Special Tools.
- B. List below applies to items in this Specification Section.
1. PACs: Provide 1 spare of each type used.
 2. HMI and Industrial Computer: Provide 1 spare.
 3. Ethernet switch: Provide 1 spare of each type.
 4. Media converters: Provide 1 spare of each type used.

1.8 QUALITY ASSURANCE

- A. Comply with the requirements of the Project Quality Plan.
- B. SAS components must be UL labeled.
- C. SAS components that are not UL certified may be furnished with a Field Evaluation label provided by a third party testing laboratory. The testing laboratory shall be approved by the Engineer.
- D. Alarm panel component manufacturers shall be ISO 9001 certified.
- E. A software quality assurance plan shall be used in accordance with IEEE 730. The plan shall describe a mechanism for orderly software development.

1.9 SOFTWARE INTELLECTUAL PROPERTY RIGHTS

- A. Furnish an irrevocable license to Owner for application software developed under this Contract, including source code.
- B. Furnish an irrevocable license to Owner for interface software for SAS components.
- C. Furnish an irrevocable license to Owner for development software for SAS components and HMI.

1.10 REQUIREMENTS FOR SERVICE PROVEN DESIGN

- A. SAS components and software shall be of a proven design. Provide evidence of at least 15 identical units that have been in successful operation in rail transit projects for a minimum of 3 years.

1.11 RELIABILITY AND MAINTAINABILITY

- A. SAS shall be fail-safe, such that a hardware or software failure condition shall not result in an unsafe equipment state.
- B. Failure of an SAS component shall not damage other equipment or inhibit status indication of the equipment.
- C. Investigate repeated failure in the SAS and provide a failure analysis report outlining the root cause of failure. Provide recommendations for correcting the failure and apply the corrective action at no cost to the Owner.
- D. The following components shall have a minimum mean time between failure (MTBF):
 - 1. PAC: 100,000 hours
 - 2. HMI: 50,000 hours
 - 3. Ethernet Switch: 200,000 hours
- E. SAS shall be capable of accommodating upgrades, bug-fixes, patches and modifications.
 - 1. Monitor the need for system modifications and supply such changes at no additional cost to the Owner for a period of 5 years.
 - 2. Fully document changes and submit documentation to the Engineer.

1.12 ENVIRONMENTAL REQUIREMENTS

- A. SAS components shall be designed to operate in the environment in which they will be installed and shall comply with and fully function in the environmental conditions specified in Section 34 21 17, TES Substation Design and Assembly.
- B. Electrical interfaces shall meet the applicable ANSI and IEEE Standards for service, EMI immunity, and surge-withstand requirements.
- C. The presence of transients on communication interfaces shall not cause disoperation or blocking of critical communications.

1.13 WARRANTY

- A. Provide on-site and remote support for the specified SAS throughout the entire warranty period. Support shall include assistance with operation and maintenance of the system.

- B. Develop a comprehensive System Support Plan and submit to Engineer.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Provide an SAS for monitoring and control of TES substation equipment at each substation capable of interfacing with other SASs and SCADA.
- B. SAS shall consist of the following components:
1. Programmable automation controllers (PAC) or industrial computers.
 2. HMI panel/Industrial Computer.
 3. Ethernet switch.
 4. Media converters.
 5. Network cables.
 6. Power supplies.
- C. Devices shall use commercial off-the-shelf products to minimize integration and future maintenance efforts.
- D. Devices shall be of the same brand and model with similar modules and programming to achieve similarity between substations.
- E. Provide terminal blocks, in accordance with SECTION 34 21 17 – TES Substation Design and Assembly, and wiring as required for alarms.
- F. SAS components shall comply with the following requirements:
1. Mechanical shock and bump withstand level: IEC 60255-21-2, Response and Withstand Section, Class 1.
 2. Vibration withstand level: IEC 60255-21-1, Response and Withstand Section, Class 2.
 3. Seismic withstand level: IEC 60255-21-3, Class 2.
 4. Electromagnetic field impulse withstand level: IEC 61000-4-3, 10 V/m.
 5. Electromagnetic field radio frequency withstand level: ANSI C37.90.2, 35 V/m.
 6. Storage Temperature: Minus 20 degrees to 60 degrees C.
 7. Operating Temperature: Zero degrees to 40 degrees C.
 8. Maximum humidity: 90 percent without condensation.
 9. Provide product data verifying compliance.
- G. SAS I/O Design:
1. Provide a list of all SAS component I/O and incorporate in the design for monitoring and indication to the HMI.

2. Provide 10 additional I/O points at each substation for indication or monitoring upon request at no additional cost to the Owner.
- H. SAS component memory and removable storage shall be solid-state, non-volatile, and shall not utilize mechanically-driven (hard-drive based) components.
- I. SAS shall be designed such that no supply-power fault will result in loss of data or require any manual re-work such as programming or reconfiguration.

2.2 POWER REQUIREMENTS

- A. SAS and PAC shall be powered by 125 Vdc plus or minus 15 percent or 24 V or 48 V plus or minus 20 percent. See SECTION 34 21 25 – TES Dc Control Power, for requirements.

2.3 TIME SYNCHRONIZATION

- A. Time Server:
1. Network Protocol: IEEE 1588 PTP C37.238
 2. Time Accuracy:
 - a. Locked to GPS: Plus or minus 50 ns RMS, 150 ns peak to peak UTC, with minimum 4 satellites tracked.
 - b. Holdover/Aging: 18 milliseconds per day
 3. GPS receiver: 12 channel parallel receiver with TRAIM
 4. PTP Server: IEEE 1588-2008 (PTP version 2) Grandmaster
 5. Mechanical/ Environmental:
 - a. Operating temperature: Minus 20 degrees C to 70 degrees C
 - b. Humidity: Up to 95 percent
 6. Compliance:
 - a. UL 60950-1
 - b. CFR Title 47 Part 15, Class A
- B. GPS Antenna:
1. Compatible with substation master clock.
 2. Roof mountable.
 3. Provide with lightning arrester.
- C. Synchronize SAS components as follows:
1. PAC and IEDs.
 2. SAS with other SASs.
 3. SAS with NTP server.
- D. SAS must synchronize using PTP.

- E. Acceptable Manufacturer/ Product: Symmetricom SyncServer SGC-1500 with L1 GPS antenna, or approved equal.

2.4 SAS NETWORK

- A. Connect IEDs to the SAS via Ethernet over fiber.
- B. Use VLANs for transfer trip between dc relay IEDs through the communications network.
- C. Communications Protocol: Ethernet TCP/IP, Modbus TCP/IP, or approved equal.

2.5 PAC

- A. Provide PACs at each substation for interfacing with other SAS components equipped with the following:
 - 1. Chassis or backplane.
 - 2. Redundant power supplies.
 - 3. Primary central processing unit (CPU).
 - 4. I/O modules.
 - 5. Ports: RJ45, RS232/RS485, USB.
 - 6. Removable flash memory with a minimum of 1 GB.
 - 7. Resident executable program and code.
 - 8. Communication Protocols: Modbus TCP/IP, DNP3, Profinet, Ethernet TCP/IP.
- B. PAC shall provide the following functions:
 - 1. Monitor and control of substation equipment.
 - 2. Log substation alarms and events as a server. The use of a dedicated or separate event log server is acceptable.
 - 3. Communicate alarms and status to the HMI and SCADA.
 - 4. Operate independently of a failure of any other SAS component or their intercommunications.
 - 5. Retain programming, configuration and memory (including data logs) even with loss or degradation of supply power.
- C. Repair and Replacement:
 - 1. PAC and associated modules shall be replaceable on site without requiring factory rewiring.
 - 2. PAC modules shall have free-standing terminals to allow changing modules without disturbing field wiring.
- D. Programming facilities (logic, available functions and supported data types) shall be non-proprietary, shall be compliant with IEC 61131-3, and shall use the C or C++ standard programming language.

2.6 HUMAN MACHINE INTERFACE (HMI) HARDWARE

- A. Provide an industrial touch screen monitor with industrial computer for the SAS HMI that is compatible with the PAC for controlling substation equipment and monitoring substation events and alarms.
- B. HMI and ancillary devices shall be flush mounted in a door of the dc switchgear.
 - 1. Locate at a height appropriate for easy access by a person of average height.
 - 2. Locate such that a person standing in front of the HMI is not standing in front of a circuit breaker.
- C. Screen:
 - 1. LED backlit LCD, active matrix TFT.
 - 2. Touch screen: Resistive or capacitive.
 - 3. Size: Minimum 22-inches diagonal.
 - 4. Resolution: Minimum 1920 x 1080 pixels.
 - 5. Brightness: Minimum 420 cd/m2.
 - 6. Contrast Ratio: 1000:1.
 - 7. Aspect Ratio: 16:9
 - 8. Input: VGA, DVI, HDMI.
- D. Industrial Computer
 - 1. Provide an industrial computer for interfacing with the PAC through the substation LAN and run HMI touch screen applications for display on the HMI screen.
 - 2. Interface with the substation LAN must use Ethernet.
 - 3. Minimum Specifications:
 - a. Rack mountable, 2U minimum
 - b. Intel Core i7
 - c. 8GB RAM
 - d. DVI, HDMI ports for connectivity to HMI display
 - e. Ethernet, USB 3.0 ports
 - f. 256GB SSD Hard Drive
 - g. Windows 7 Professional 64-bit
 - h. Operating Temperature: Minus 40 to 74 degrees C
 - i. Alarm Output for Monitoring by PAC and SCADA
 - j. Dual Power supply

2.7 HMI DESIGN AND SOFTWARE APPLICATIONS

- A. Provide HMI and software applications similar to the layouts shown on Contract Drawings.
- B. Design:
 - 1. Navigation bar:
 - a. Accessible from any application.
 - b. Contains buttons to navigate to other applications.
 - 2. Buttons, text, and icons:
 - a. Sized appropriately for ease of use.
 - b. Designed with button responses to show button actions, e.g. selected, not selected.
 - c. Intuitively designed and representative of the equipment being monitored or controlled.
 - 3. Input keyboards:
 - a. Alpha: QWERTY.
 - b. Numeric: 10-key.
 - c. Automatically display the appropriate keyboard when an input is required.
 - d. Provide a cancel button that closes the keyboard.
- C. Provide the following HMI software applications:
 - 1. Header Screen:
 - a. Displayed at all times and similar in design to what is shown on Contract Drawings.
 - b. Display the time, date, name of substation, system name, and SCADA control panel.
 - c. Time and Date:
 - 1) Time shall be synchronized with time server.
 - 2) Time format: 00:00:00.
 - 3) Date format: December 10, 2013.
 - d. SCADA Control Panel: Contains local/remote buttons for enabling or disabling remote control by SCADA and indicating the current control status
- D. Control Screen:
 - 1. Displays equipment status and provides local control of substation equipment.

2. Status indications:
 - a. Display in real time and refresh at least every second.
 - b. Display local/remote status for each breaker.
 - c. Display test/disconnected status for each breaker.
 - d. Display energized/de-energized status for equipment.
 - e. Display opened/closed status of disconnect switches.
 - f. Display adjacent substation breaker energized/de-energized status.
 - g. Display line and load voltage and current for ac and dc breakers
3. Color Code:
 - a. Energized Equipment: Red.
 - b. De-energized Equipment: Green.
 - c. Uncertain Equipment State: Grey.
 - d. Color shall indicate the energized, de-energized, or uncertain state of each piece of equipment, including the busbar, feeder cables, transformer, and rectifier.
4. Control operation:
 - a. Control operation sequence:
 - 1) Select object.
 - 2) Confirm object selection (confirm or cancel).
 - 3) Select operation (close, open, or cancel).
 - 4) Confirm operation (confirm or cancel).
 - b. A combined message window shall not be used; each step shall have an individual window. Collapse previous windows after selection.
 - c. Selection, confirmation, and execution information must be clear and displayed without abbreviations.
 - d. Selection and confirmation of operation shall be automatically cancelled after 60 seconds if the operation is not executed.
 - e. Provide a cancel button for each control step.
5. Bypass Load Measuring:
 - a. Provide option for dc breaker close operation that allows selection of bypass mode, which bypasses the load measuring system.
 - b. Upon confirmation of this operation, a warning shall flash on the screen stating "LOAD MEASURING BYPASSED."

6. Password Protection:
 - a. Selection of an object shall be password protected.
 - b. Selection of bypass load measuring shall require an additional level of password protection.
 7. If a protection function is triggered, the related equipment alarm field shall flash until it is acknowledged.
- E. Alarm Screen:
1. Display each alarm shown in Alarm Points List, at the end of this Section.
 2. Layout: See Contract Drawings.
 3. New Alarm: Flashing red.
 4. Acknowledged alarm: Solid red.
 5. New alarms resolved before acknowledgment: Flashing yellow.
 6. Resolved Alarm: Grey.
 7. Alarms shall be acknowledged by touching an Acknowledge button.
 8. The Alarms button in the navigation bar must follow the same color logic as above.
- F. Events Screen:
1. Layout and Format: See Contract Drawings.
 2. Log each alarm and equipment event with time and date stamp.
 3. Event log shall display a minimum of 1000 events. Implement page turn buttons to view alarms exceeding the length of one page.
 4. Events must not be capable of being deleted.
 5. Overwrite the oldest entry in the log with new events.
 6. Display the most recent entry at the top of the screen.
 7. Events shall be downloadable to a laptop and USB flash drive without deletion from the SAS.
 8. File format: Compatible with Microsoft Excel.
- G. Network Status Screen:
1. Layout: See Contract Drawings.
 2. Application must indicate the communication/operational status of each SAS component.
 3. Normal: Green.
 4. Error: Red.
 5. Unknown: Yellow.

- H. Settings Screen:
 - 1. Provide a settings screen application for adjusting time, editing user management/password settings, editing alarm screen windows, and viewing PAC I/O Status.
 - 2. Time setting: Provide both manual adjustment options and automatic SNTP synchronization with an NTP server.
 - 3. Viewing permissions: No password required.
 - 4. Editing permissions: Password required.
- I. Help Screen:
 - 1. Provide a help screen containing operational instructions and descriptions for the SAS HMI applications described above.
 - 2. Organize and display help topics in an outline format with individual topics that expand to display information when selected.
 - 3. Provide a legend defining the symbols and abbreviations used in the HMI screens.

2.8 HMI DEVELOPMENT SOFTWARE

- A. Provide a user-friendly PC/Windows based development environment suitable for application software updating and modification.
- B. The environment shall be dedicated solely to creating control/monitoring software. It shall use familiar, standardized editors bundled into a single application.
- C. The environment shall include a graphics editor and online help that simplify development of application software.
- D. The environment shall comply with Microsoft Windows Graphical User Interface (GUI) and IEC 61131-2 and IEC 61131-3 standards for programmable logic controllers.
- E. Provide de-bug, documentation and machine startup facilities in the environment.
- F. Provide complete user training for the application of development environment in accordance with SECTION 01 79 00, Demonstration and Training.
- G. Provide complete user documentation for the environment complying with SECTION 01 78 23, Operations and Maintenance Data.
- H. Software must be compatible with Windows 7.
- I. Approved Manufacturer: Wonderware, Vijeo Designer, or approved equal.

2.9 ETHERNET SWITCH

- A. Provide industrial managed Ethernet switches for connecting SAS components and SCADA.
- B. Ports:
 - 1. Copper: 10/100/1000 Base T RJ45.
 - 2. SFP: 100/1000 base-X for fiber.

3. Spare: 20 percent.
- C. Layer 2 Function:
1. VLAN: Up to 8 groups.
 2. Port Configuration.
 3. QoS.
 4. Security: MAC filter, switch access.
- D. Operating temperature: minus 40 to 70 degrees C
- E. Redundant power supply.

2.10 ENGINEERING LAPTOP COMPUTER

- A. Provide a laptop computer for use to interface with the SAS and other IEDs in the substation LAN.
- B. Development and interface software for IEDs and SAS components must be preinstalled on the computer.
- C. End user software and firmware developed for IEDs and SAS components must be loaded on the laptop computer with files descriptively labeled showing their intended purpose.
- D. Specifications:
1. Intel Core i7
 2. 8GB RAM
 3. VGA, HDMI ports
 4. Ethernet, USB 3.0 ports
 5. 256GB SSD Hard Drive
 6. Windows 7 Professional 64-bit
 7. 14-inch HD display
 8. LTE mobile broadband
 9. MIL-STD-810G certified for shock, drop, vibration, temperature and humidity
- E. Approved Manufacturer: Panasonic Toughbook 53 or approved equal.

2.11 INTERIOR BLUE LIGHT AND RESET SWITCH

- A. Provide a blue light LED for substation alarm indication located above the HMI panel.
- B. The blue light shall have a label "SUBSTATION TROUBLE ALARM."
- C. The light shall operate as follows:
1. Light flashes when an SAS alarm/event occurs.
 2. Light is solid when all alarms are acknowledged.

3. Light turns off when all alarms are resolved.
- D. Alarm acknowledgement shall be provided by a button on the HMI.
- E. Blue light shall be fail safe.

2.12 EXTERIOR BLUE LIGHT

- A. Activate exterior blue light (see SECTION 34 21 17 – TES Substation Design and Assembly) for the following alarms:
 1. Smoke alarm.
 2. Intrusion Zone 1 alarm (entry doors).
 3. Intrusion Zone 2 alarm (exterior equipment access doors).
 4. Ac breaker trip.
 5. Dc breaker trip without reclose.
 6. Rectifier transformer over temperature (first stage).
 7. Rectifier over temperature (first stage).
 8. Substation high temperature.
 9. Diode failure.
 10. Frame fault.
- B. For Intrusion Zone 1 alarm, provide a time delay, and an override in the HMI only, to allow authorized persons to enter the substation and override the alarm without activating the exterior blue light.

2.13 FACTORY ASSEMBLY

- A. SAS hardware installation shall be identical and interchangeable between substations, including wire numbering, and marking.
- B. Wiring: Interconnecting wiring shall be 14 AWG 600 V switchboard wire in accordance with SECTION 34 22 10 – TES Low Voltage Conductors and Cable.
- C. Wire and Cable Identification:
 1. Wire and cables shall be identified whenever they enter or leave a housing or enclosure, and at all terminals.
 2. Provide labels in accordance with SECTION 34 22 10 – TES Low-Voltage Conductors and Cable.
- D. Terminals: DIN rail mounted.
- E. Spare Capacity:
 1. Design system with a minimum of 30 percent spare capacity. This shall include:
 - a. Wiring terminals.
 - b. Inputs and outputs of same kind per modular controller unit.

c. Spaces for additional modules for each modular PAC unit.

F. Workmanship:

1. Install equipment, enclosures, wire, cable, conduits and wireways in a neat and secure manner, level and plumb, and in true alignment with adjoining work.
2. Equipment enclosures and installation shall comply with local and national codes including, but not limited to UL 508A and NFPA 70.

2.14 ALARMS POINTS LIST

A. Provide the following points for control and monitoring by the SAS and SCADA at each substation:

Device	Description	Device No.	Status	Control
Ac Circuit Breaker and Protective Relay	Breaker closed/open status	52	X	
	Breaker test/disconnected status		X	
	Remote Trip Command		X	X
	Remote Close Command		X	X
	Undervoltage	27	X	
	Overvoltage	59	X	
	Loss of Control power	27ac	X	
	Phase Sequence	47	X	
	Time Delay Overcurrent Phase	51	X	
	Instantaneous Overcurrent Phase	50	X	
	Time Delay Overcurrent Neutral	51N	X	
	Instantaneous Overcurrent Neutral	50N	X	
	Local/Remote Indication	43	X	
	Access Door	33ac	X	
	Ac Breaker Trip Healthy Coil		X	
	Ac Lockout Relay Healthy Coil		X	
	Ac Protective Relay Status		X	
	Ac Lockout Relay	86	X	
	Breaker Connected Status		X	
Power Meter	V, A, kW, kVAr, kWh		X	

Device	Description	Device No.	Status	Control
	Power Meter Status		X	
Dc Feeder Breaker and Protective Relay (for each feeder breaker)	Breaker closed/open status	172	X	
	Breaker test/disconnected status		X	
	Remote Trip Command		X	X
	Remote Close Command		X	X
	Local/Remote Indication	43	X	
	Incomplete Sequence	148	X	
	Overvoltage	159	X	
	Undervoltage	127	X	
	Rate of Rise di/dt	151	X	
	Imax	150	X	
	Loss of Control power	27dc	X	
	Dc Voltage		X	
	Dc Current		X	
	Transfer Trip	85	X	X
	Transfer Trip Lockout	85L	X	X
Access Door	33dc	X		
Positive Disconnect Switch	Open Indication	89P	X	
	Close Indication	89P	X	
Negative Disconnect Switch	Open Indication	89N	X	
	Close Indication	89N	X	
Rectifier Transformer	Over Temperature 1 Alarm	49T1	X	
	Over Temperature 2 Trip	49T2	X	
	Temperature Monitor Status		X	
Rectifier	Over Temperature 1 Alarm	26R1	X	
	Over Temperature 2 Trip	26R2	X	
	Temp Monitor Status		X	

Device	Description	Device No.	Status	Control
	Diode Failure 1 Alarm	98R1	X	
	Diode Failure 2 Trip	98R2	X	
	Rear Access Door	33R	X	
	Reverse Current	32	X	
Battery Charger	Undervoltage	27Batt	X	
	Overvoltage	59Batt	X	
	Charger Summary Alarm		X	
TES Substation General	Ac Control Power Undervoltage Alarm	127		
	Dc Control Power Undervoltage Alarm	127		
	ETS	5	X	
	High Temperature Alarm		X	
	Smoke alarm		X	
	Intrusion Zone 1 (access doors)		X	
	Intrusion Zone 2 (exterior equipment access doors)		X	
	HVAC 1 Status Alarm		X	
	HVAC 2 Status Alarm		X	
Rail-to-Ground Monitor	Timed Overvoltage		X	
	Instantaneous Overvoltage		X	
	Timed Overcurrent		X	
	Instantaneous Overcurrent		X	
	R2G Status		X	
Ground Fault Detector	Grounded Structure Alarm	64GS	X	
	Hot Structure Trip	64HS	X	
Dc Disconnect Switch	Open Indication		X	
	Close Indication		X	
SAS	PAC Status (each)		X	
	Network Switch Status (each)		X	

Device	Description	Device No.	Status	Control
	IED Status (each)		X	
	HMI/Industrial Computer Status		X	
	Time Server Status		X	
	Communication Status to Adjacent substation (each)		X	

2.15 LWAN FOR TRANSFER TRIP

- A. Connect mainline substations together as a local wide area network (LWAN) for transfer trip as indicated on Contract Drawings.
- B. Connect fiber from adjacent substations to the Ethernet Switch/ Gateway in each substation.
- C. See SECTION 34 22 15 – TES Fiber Optic Cable, for fiber installation requirements.
- D. See SECTION 34 21 19 – TES DC Switchgear, for transfer trip functional requirements.

2.16 SOURCE QUALITY CONTROL

- A. Factory Design Tests:
 - 1. Perform with all accessories attached in accordance with design tests in IEEE C37.90.
 - 2. Demonstrate electrical operation and accuracy of all components.
 - 3. Test from alarm panel to initiating devices for proper operation.
- B. Factory Production Tests:
 - 1. Test all components for proper operation and function.
 - 2. Test control wiring continuity by actual electrical operation of control devices.
 - 3. Test inputs and outputs for proper operation and short circuits.
 - 4. Communications: Verify communications and SCADA information is retrievable from the SCADA interface point.
 - 5. HMI: Verify that display, screens, and user interface operate in accordance with Specifications.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install SAS in VMF substation as required in Part 2, above, in the article titled "Factory Assembly."

3.2 INTEGRATION WITH SCADA NETWORK

- A. Program and configure SAS switches and SAS components to establish communication between substations and to a host SCADA workstation over the SCADA network.
- B. Configure dc multifunction IEDs and SAS components to communicate transfer trip signals over the Ethernet based communications network using VLAN.

PART 4 - MEASUREMENT AND PAYMENT**4.1 MEASUREMENT**

- A. The quantities of accepted work will be measured in the following units. All measurements will be plan measure except for authorized changes.
 - 1. Description: Lump Sum

4.2 PAYMENT

- A. Payment will be made at the respective unit or lump-sum price listed in the proposal and shall be full compensation for all labor, materials, and equipment necessary to complete the respective unit in place. There will be no separate measurement or payment for any item of work not specifically identified and listed in the proposal, and all such work shall be considered a subsidiary item with all costs pertaining thereto included in the prices for other items listed in the proposal. At the Engineer's option, partial payment may be made for any lump sum item listed in the proposal, providing that the Contractor is diligently and satisfactorily pursuing full completion of such partially complete item in accordance with the approved job progress schedule.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 34 21 33**RAIL-VOLTAGE MONITORING AND GROUNDING SYSTEM****PART 1 - GENERAL****1.1 SUMMARY**

- A. This Section includes the following:
 - 1. Requirements for the Rail Voltage Monitoring and Grounding System for each mainline TES substation.
 - 2. Rail Voltage Monitoring and Grounding System includes a bi-directional switching device and an integrated Device 64V protective relay function for voltage and current monitoring and tripping of dc feeder circuit breakers.

1.2 RELATED SECTIONS

- A. SECTION 01 33 00 – Submittal Procedures
- B. SECTION 34 21 17 – TES Substation Design and Assembly
- C. SECTION 34 21 25 – TES DC Control Power
- D. SECTION 34 21 31 – TES Substation Automation System (SAS)
- E. SECTION 34 21 80 – TES Spare Parts and Special Tools
- F. SECTION 34 21 90 – TES Testing
- G. SECTION 34 22 10 – TES Low-Voltage Conductors and Cable

1.3 ABBREVIATIONS AND ACRONYMS

- A. Rail-to-Ground System: Rail-Voltage Monitoring and Grounding System.
- B. R2G: Rail Voltage Monitoring and Grounding System.
- C. SAS: Substation Automation System

1.4 DEFINITIONS

- A. Controller: A programmable logic controller (PLC) and human machine interface (HMI) device.
- B. Rail voltage:
 - 1. Zero potential: Equal to earth potential.
 - 2. Positive voltage: Ground positive with respect to rail.
 - 3. Negative voltage: Ground negative with respect to rail.
- C. Current:
 - 1. Positive current is current that flows from ground to rail.

2. Negative current is current that flows from rail to ground.

1.5 SUBMITTALS

- A. Procedures: SECTION 01 33 00 – Submittal Procedures.
- B. Product Data:
 1. Product descriptions and catalog data for system components.
 2. Information concerning design and application ratings.
 3. Information concerning service, performance and reliability and locations where units are currently in service.
 4. Measures used to prevent failure of switch.
- C. Spare Parts and Special Tools:
 1. Submit a list of spare parts to be provided under this Section.
 2. Submit at the same time as product data.
 3. Provide part numbers for each part, including a detailed breakdown of each spare part assembly and set, as defined in SECTION 34 21 80 – TES Spare Parts and Special Tools.
 4. Submit a list of special tools to be provided under this Section, as defined in Section 34 21 80, TES Spare Parts and Special Tools.
- D. Shop drawings:
 1. Manufacturer's arrangement and outline dimensions for each device.
 2. Logic diagram.
 3. Wiring schematics.
 4. Connection diagrams.
 5. HMI screen shots.
- E. Submit test procedures that comply with SECTION 34 21 90 – TES Testing.
 1. Design Test.
 2. Production Tests: Provide production test reports for each component.
- F. Submit test reports that comply with SECTION 34 21 90 – TES Testing.
 1. Design Test.
 2. Production Tests: Provide production test reports for each component.
- G. Operation and Maintenance Data:
 1. Submit manufacturer's operating and maintenance instructions on products specified in this Section, including the following:
 - a. Submittal information identified above.

- b. Parts list, illustrations and diagram for components for products specified in this Section.
 - c. Wiring diagram.
2. Submit immediately after approval of product data.

1.6 SPARE PARTS

- A. Provide spare parts in accordance with SECTION 34 21 80 – TES Spare Parts and Special Tools.
- B. List below applies to items in this Specification Section.
 1. Rail-to-Ground System complete assembly, including PLC, HMI, and switch: Provide 1 assembly.
 2. Enclosure door key: Provide 2 spare keys for each substation.

PART 2 - PRODUCTS

2.1 RAIL-TO-GROUND SYSTEM (R2G)

- A. General Requirements:
 1. Provide an R2G at each TES substation for monitoring and protecting against rail-to-ground overvoltages and overcurrents.
 2. R2G shall be of proven design with minimum 3-years successful operation in a rail application.
 3. R2G shall be a self-contained unit with a bi-directional switching element, voltage transducer, current transducer, and PLC/HMI controller suitable for use in a 750 Vdc traction power system.
- B. Controller:
 1. Dedicated PLC.
 2. Form C contacts for overvoltage, overcurrent, and summary alarm signals.
 3. Sufficient memory to store 500 events
- C. HMI Display:
 1. Type: Industrial LCD touch screen monitor with resistive touch.
 2. Size: 12-inch active matrix, minimum.
 3. Color: 18-bit color.
 4. Resolution: 1600 x 1200.
 5. Contrast Ratio: 600:1.
- D. Bi-Directional Switch:
 1. Composed of phase-controlled stud-type thyristors.
 2. Continuous Current Rating: Minimum 800 A.

3. Current Withstand: 30 kA for 100 ms and 50 kA for peak value half sine wave.
- E. Enclosure: Steel, with a latching access door that is lockable; all enclosures keyed alike.
- F. LED indications:
 1. Provide LED indicators mounted on the enclosure
 - a. Red LED: Switch is closed and conducting
 - b. Yellow LED: Event has occurred. LED will remain flashing until acknowledged.
- G. Acknowledge Button:
 1. Provide a momentary push button on the outside of the enclosure for the local acknowledgement of the yellow LED event alarm
- H. Control power: Refer to Section 34 21 25 TES Dc Control Power
- I. Communications:
 1. Protocol: Modbus TCP/IP, Ethernet TCP/IP, or approved equal.
 2. Device shall be capable of being remotely monitored by the SAS, as specified in Section 34 21 31, TES Substation Automation System (SAS), and SCADA.
 3. R2G shall communicate alarms and switch status to the SAS.

2.2 HMI APPLICATION DESIGN

- A. General Design Requirements:
 1. Provide HMI applications for displaying event notifications, rail voltage and current data, and device configuration information.
 2. HMI must provide a means of field programming time and date, voltage and current triggers, and communications settings.
 3. HMI must have password protection for functions related to changing the configuration of the device.
 4. Current date and time must be displayed at all times.
 5. R2G must synchronize time and date with the SAS.
- B. Event Log:
 1. Record events and retain for seven days minimum in non-volatile memory.
 2. Create events for the following:
 - a. Overvoltage, with voltage at the time of event;
 - b. Overcurrent, with current at the time of event;
 - c. Switch trigger;
 - d. Thyristor fail;

-
- e. Breaker trip;
 - f. Breaker lockout;
 - g. R2G fault.
- 3. Events must be date and time stamped.
 - 4. Events shall be downloadable onto a laptop computer and USB thumb drive.
 - 5. Event log must be viewable using Microsoft Excel.
 - 6. See Section 34 21 17, TES Substation Design and Assembly, for requirement to supply software.
- C. Waveform Capture:
- 1. Log and capture voltage and current data upon voltage and current triggers.
 - 2. Waveform information shall be downloadable onto a laptop computer and USB thumb drive.
 - 3. Waveform information must display the voltage and current before and after the trigger event.
 - 4. Log must be viewable using Microsoft Excel.
- D. Overvoltage Protection:
- 1. Long-Time Overvoltage:
 - a. Voltage setting range: 0 to 200 V, positive or negative, in 1 V increments.
 - b. Time delay setting range: 0 to 20 seconds in 0.1-second increments.
 - c. Default setting: Plus/minus 50 V and 10-second delay.
 - 2. Short-Time Overvoltage:
 - a. Voltage setting range: 0 to 200 V, positive or negative, in 1 V increments.
 - b. Time-delay setting range: 0 to 10 seconds in 0.1-second increments.
 - c. Default setting: Plus/minus 95 V and 1-second delay.
 - 3. Each voltage trigger shall close the R2G switch.
- E. Switch Operation:
- 1. Time duration of closure shall be dependent on the current flowing through switch and the natural characteristics of the thyristor.
 - 2. Provide an option for disabling conduction of the switch in each direction. This option must be field adjustable using the HMI.
- F. Overcurrent Protection:
- 1. When switch is conducting, the R2G shall monitor current through the switch and provide two overcurrent-protection triggers.

2. Long-time overcurrent:
 - a. Current setting range: 0 to 100 A, positive or negative, in 1 A increments.
 - b. Time-delay setting range: 0 to 60 seconds in 0.1-second increments.
 - c. Default setting: Plus/minus 5 A and 50-second delay.
 3. Instantaneous overcurrent:
 - a. Current setting range: 0 to 100 A, positive or negative, in 1 A increments.
 - b. Time-delay setting range: 0 to 60 seconds in 0.1-second increments.
 - c. Default setting: Plus/minus 20 A and 0.5-second delay.
 4. Each overcurrent stage shall trigger any one of three user-selectable responses:
 - a. Trip and reclose dc breakers with breakers reclosing one-by-one.
 - b. Trip and lockout dc breakers.
 - c. Trip and lockout dc breakers and transfer trip adjacent substations.
 5. The R2G shall trip and lockout the breaker on a repeat overcurrent trigger if it occurs within a user-adjustable time. The user-adjustable settings are as follows:
 - a. Repeat Trigger Function: Enabled, Disabled.
 - b. Time-Window Setting range: 2 to 60 seconds in 1-second increments. The setting shall not be less than the instantaneous-overcurrent time delay.
 - c. Default setting: 60 seconds.
- G. If the current or voltage value measured by the R2G is lower than its setting, the grounding device counters shall be reset.
- H. R2G shall be fail-safe as described in the following two scenarios, at minimum:
1. A malfunction of the control component shall cause grounding switch to close until control component is restored.
 2. An alarm signal shall be sent to SAS if a thyristor or control component fails.

2.3 CONNECTIONS

- A. Ground R2G enclosure and internal ground reference busbar to the structure earth using 4/0 copper, 2 kV insulated cable, as specified in Section 34 22 10, TES Low-Voltage Conductors and Cable.
- B. Connect the R2G negative reference to the negative return using 4/0 copper 2 kV insulated cable.

2.4 SOURCE QUALITY CONTROL

- A. Factory Design Tests:
1. Perform on the first unit before it is installed in a substation. Comply with requirements for factory design tests in Section 34 21 90, TES Testing. This test must be conducted and will not be waived on the basis of existing test reports.
 2. Perform a heat run test to verify 800A continuous current rating.
 3. Perform functional tests to verify the requirements in this Section.

PART 3 - EXECUTION

Not Used.

PART 4 - MEASUREMENT AND PAYMENT**4.1 MEASUREMENT**

- A. The quantities of accepted work will be measured in the following units. All measurements will be plan measure except for authorized changes.
1. Description: Lump Sum

4.2 PAYMENT

- A. Payment will be made at the respective unit or lump-sum price listed in the proposal and shall be full compensation for all labor, materials, and equipment necessary to complete the respective unit in place. There will be no separate measurement or payment for any item of work not specifically identified and listed in the proposal, and all such work shall be considered a subsidiary item with all costs pertaining thereto included in the prices for other items listed in the proposal. At the Engineer's option, partial payment may be made for any lump sum item listed in the proposal, providing that the Contractor is diligently and satisfactorily pursuing full completion of such partially complete item in accordance with the approved job progress schedule.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 34 21 40**TES DC DISCONNECT SWITCHES****PART 1 - GENERAL****1.1 SUMMARY**

- A. This Section includes the following:
 - 1. Manual, no-load-break, non-grounding, pole-mounted dc disconnect switches mounted inside non-metallic switch enclosure for installation on tapered tubular poles or ornamental joint use poles.
 - 2. Manual, no-load-break, non-grounding, wall-mounted dc disconnect switches to connect/disconnect dc power to Vehicle Maintenance Facility (VMF) OCS.
 - 3. Manual, no-load-break, non-grounding, pad-mounted dc disconnect switches located at each TES substation to connect/disconnect substation from OCS.

1.2 RELATED SECTIONS

- A. SECTION 34 21 05 – Common Work Results for TES
- B. SECTION 34 21 17 – TES Substation Design and Assembly
- C. SECTION 34 21 31 – TES Substation Automation System (SAS)
- D. SECTION 34 21 70 – TES Vehicle Maintenance Facility (VMF) Interlocking
- E. SECTION 34 21 90 – TES Testing
- F. SECTION 34 22 29 – TES Raceway and Equipment Hangers and Supports
- G. SECTION 34 23 78 – OCS Disconnect Switch Installation

1.3 REFERENCED STANDARDS

- A. Section incorporates by reference the latest revisions of the following documents:
- B. ASTM International (ASTM)
 - 1. ASTM B187/B187M, Standard Specification for Copper, Bus Bar, Rod and Shapes and General Purpose Rod, Bar, and Shapes
- C. Institute of Electrical and Electronics Engineers (IEEE)
 - 1. IEEE C2, National Electrical Safety Code
 - 2. IEEE C37.34, Standard Test Code for High-Voltage Air Switches
- D. National Fire Protection Association (NFPA)
 - 1. NFPA 70, National Electrical Code

1.4 SUBMITTALS

- A. Procedures: Section 01 33 00, Submittal Procedures.

-
- B. Product Data:
1. Complete manufacturer's descriptions and catalog data for each type of switch including the following:
 - a. Materials.
 - b. Isolation method, circuit and wiring diagrams.
 - c. Operating mechanism and assembly details.
 - d. Model numbers or serial numbers.
 2. Complete manufacturer's descriptions and catalog data for enclosure including the following:
 - a. Materials.
 - b. Hardware.
 3. Fiberglass framing channel or other spacer for pad-mounted switches.
- C. Shop Drawings:
1. Manufacturer's general and detailed dimensional drawings including the following:
 - a. Enclosure for pad-mount and pole-mount type and polycarbonate shroud for wall-mount type.
 - b. Switch.
 - c. Manual operator.
 - d. Insulators.
 - e. Mounting brackets and mounting for each type of switch mounting.
 - f. Signage.
 2. Each shop drawing shall provide a complete list of its component materials for that specific type of assembly, including the identification of materials such as pipes, brackets, bolts, cables, jumpers and cable connectors.
 3. Pole-mounted switches: See Section 34 23 78, OCS Disconnect Switch Installation for special requirements for assembly references.
 4. Submit for approval before installing the first switch.
- D. Instructions:
1. Manufacturer's recommended installation instructions, including checks/tests after installation.
 2. Manufacturer's adjustment procedures.
- E. Manufacturer's certification that each switch has been correctly installed and adjusted.
- F. Submit test procedures that comply with Section 34 21 90, TES Testing.
1. Design Tests.

2. Production Tests.
- G. Submit test reports that comply with Section 34 21 90, TES Testing.
1. Design Tests: Provide design test reports for each type of disconnect switch within 30 Days after completion of testing.
 2. Production Tests: Provide production test reports for each disconnect switch within 30 Days after completion of testing.
- H. Operations and Maintenance Data:
1. Submit manufacturer's operating and maintenance instructions on products specified in this Section, including the following:
 - a. Submittal information identified above.
 - b. List of recommended spare parts.
 2. Submit immediately after approval of product data.

PART 2 - PRODUCTS

2.1 TYPE

- A. Single-pole, single-throw, non-load-break bolted pressure switch, non-grounding with manual operator. Design shall comply with the applicable requirements given in IEEE C37.34 and ASTM B187/B187M.

2.2 SWITCH RATINGS

- A. General:
1. Minimum insulation level: 3.7 kV rms.
 2. Momentary peak current withstand: Not less than 90 kA.
 3. Short time current: Not less than 70 kA, average, for 0.25 seconds.
 4. Continuous current rating: As indicated for each type; switch contact temperature rise shall not exceed 50 degrees C above a maximum ambient temperature of 40 degrees C.
- B. Voltage: 1000 Vdc
- C. Continuous Current:
1. Pole Switches: 2000 A
 2. Wall-Mounted Switches: 1000 A
 3. Pad-Mounted Switches: 2000 A

2.3 SWITCH CONSTRUCTION

- A. Switch Contacts:
1. Moving and stationary contact surfaces shall be silver-plated copper or silver-plated copper alloy.

2. Contacts shall be self-aligning, wear-compensating, with wiping action on switch closing.
 3. Hinge and jaw contacts shall be bolted-pressure type with non-ferrous or stainless steel self-clamping mechanism, or other approved high-pressure type contact arrangement.
- B. Other Current-Carrying Parts: High conductivity copper or copper alloy.
- C. Emergency Operation: Switch shall be capable of breaking load currents under emergency conditions.
- D. Cable Termination: Provide separate insulated cable strain posts for termination of cables, designed to prevent cable movement from affecting adjustment of switch.

2.4 SWITCH STATUS

- A. For pad-mounted switches, provide position switch.
- B. Auxiliary Contacts: Isolate from 750 Vdc to prevent inadvertent shorting of 750 Vdc with low-voltage control signals used for switch position.

2.5 CABLE TERMINATIONS

- A. Line and load side terminals: Silver-plated copper bus, ASTM B187/B187M.
- B. Provide sufficient size bus to accommodate the number and size of dc power copper cables, entering from below or from above, as indicated.
- C. Buses shall accommodate the number and size of feeder cables as indicated on the Contract Drawings and have provisions for NEMA drilled (2 or 4 hole) cable terminal lugs.
- D. Clearance: Switch design shall provide a minimum 2-inches clearance from live parts to grounded parts after cables are terminated. Minimum clearance shall be maintained at all points of travel while the switch is being thrown.

2.6 INSULATION

- A. Switch assembly shall have double insulation, consisting of two independent insulators each rated for the system voltage, as follows:
1. Between the switch and the operating handle.
 2. Between the switch and the pole, wall, or pad upon which it is mounted.

2.7 SWITCH ENCLOSURE FOR PAD-MOUNT AND POLE-MOUNT SWITCHES

- A. Description:
1. Material: Rigid, fiberglass-reinforced polyester.
 2. Design:
 - a. Rain-tight, with design conforming in general to NEMA 250 Type 4X.
 - b. Ventilated, tamperproof.
 - c. Weatherproof, heavy service construction, suitable for outdoor application.

- B. Size and Arrangement:
1. Size enclosure to accommodate switch, internal linkages, operating gear, cabling, and terminations without electrical shorting or damage due to chafing on feeder cable insulation.
 2. Maintainable components shall be readily accessible through the door opening.
 3. Provide sufficient space for the manipulation of required tools.
- C. Materials:
1. Minimum 1/4-inch thick polyester with 40 percent glass fiber and 60 percent resin.
 2. Resin system:
 - a. Compounded for fire retardancy and good dielectric characteristics.
 - b. Complying with UL 94 V E-1 (minimum) flammability rating.
- D. Exterior Finish:
1. Polyester base material coating, 18 to 20 mils thick; Pleogen 2907 Iso-Gel, American Colors 66-20060, or approved equal.
 2. Color: Subject to approval of Engineer.
- E. Door and Hardware:
1. Heavy duty, single hinged door.
 2. Swing: Capable of opening through minimum 180-degrees.
 3. Sealing gasket: Neoprene, memory-type, that ensures a tight seal.
 4. Latching mechanism:
 - a. Three-point door latching assembly (top, middle, and bottom)
 - b. Handle: Padlockable.
 - c. Use non-metallic parts inside enclosure; or
 - d. Insulate metal parts inside enclosure with fiberglass channel such that no metal parts are visible inside enclosure; or
 - e. Coat with high dielectric epoxy coating material, 15 mils minimum thickness.
 5. Hinge: Continuous, stainless steel, full length of door, 12 gauge minimum, concealed with door in closed position.
 6. Locking Hasp: Stainless steel.
- F. Drip shield: Fiberglass, installed to protect door hardware from dripping water, ice/snow build-up, and settling dust.
- G. Vents:
1. Adequate size to ensure heat dissipation and prevent condensation,

2. Weatherproof, rodent proof, and tamperproof design.
- H. Drain Plugs:
1. Provide automatic, corrosion-proof, condensation drain plugs installed in enclosure bottom.
 2. Plugs shall be tamperproof design.
 3. Provide with stainless steel screening.
- I. Mounting Provisions:
1. Enclosure for switches indicated on OCS poles shall have provisions for mounting to a pole
 2. Enclosure for switches indicated at each substation shall have provisions for pad mounting.

2.8 WALL MOUNTED SWITCH

- A. Wall Switch Insulated Standoffs: Fiberglass-reinforced thermoset polyester, moisture and heat resistant; rated minimum 1000 V.
- B. Shield: Clear polycarbonate, minimum 1/4-inch thick.

2.9 MANUAL OPERATOR

- A. General:
1. Each switch shall have a manual operating mechanism for operation of switch.
 2. Operating mechanism shall operate smoothly and easily
 3. Handle Position:
 - a. Closed: Handle in the up position.
 - b. Open: Handle in the down position.
- B. Pole-Mounted Switch:
1. Provide insulated linkage from handle at ground level to switch.
 2. Handle shall be padlockable in the open or closed position.
- C. Wall-Mounted Switch:
1. Provide insulated linkage from handle at floor level to switch.
 2. Handle shall be padlockable in the open or closed position.
 3. Mechanical Interlock: Provide in accordance with Section 34 21 70, TES Vehicle Maintenance Facility (VMF) Interlocking and APS
- D. Pad-Mounted Switch: Provide a dead-front operating handle.

2.10 SIGNAGE

- A. Provide "ON" and "OFF" labels for manual operators.

- B. Signage on Face of Enclosure:
1. Switch data nameplate complying with Section 34 21 17, TES Substation Design and Assembly, Article titled "Identification."
 2. "Danger High Voltage" sign complying with Section 34 21 17, TES Substation Design and Assembly, Article titled "Warning Signs."
 3. "DO NOT OPERATE UNDER LOAD" signage using materials specified for nameplates in Section 34 21 17, TES Substation Design and Assembly, Article titled "Identification" with size as specified for equipment nameplates.

2.11 PADLOCKS

- A. Comply with requirements in Section 34 21 05, Common Work Results for TES.

2.12 SOURCE QUALITY CONTROL

- A. Switch assemblies shall be factory-assembled and precision aligned on base material and not be susceptible to distortion during installation.
- B. Factory Design Tests:
1. Perform on one switch of each type to prove compliance with Specifications.
 2. Tests shall be conducted generally in accordance with those described in IEEE C37.34, including the following:
 - a. Dielectric tests.
 - b. Short time current test.
 - c. Temperature rise test.
 - d. Interrupting current test: Test and certify that switches are suitable for use on dc circuits with prospective fault current capabilities of 100 kA.
 3. Mechanical Tests:
 - a. Subject a sample switch and assembly to a maximum number of openings and closings to establish a life cycle capability.
 - b. Perform continuous and overload current-temperature tests before and after.
 - c. Perform inspection, using a feeler gauge (or other approved method), of each contact and assembly point.
 - d. Acceptance criteria:
 - 1) Pass continuous and overload current-temperature tests.
 - 2) No gaps at contact or assembly points.
 - 3) Operating handle mechanism shall operate smoothly and easily.
- C. Factory Production Tests:
1. Perform on each switch to check the quality and uniformity of workmanship and materials used.

2. Tests shall be conducted generally in accordance with those described in IEEE C37.34, including the following:
 - a. Operation of all components.
 - b. Power frequency dielectric withstand.
 - c. Electrical resistance of current path.
 - d. Insulation resistance and high-potential test.

PART 3 - EXECUTION

3.1 SWITCH INSTALLATION

- A. Install pole-mounted disconnect switches in accordance with Section 34 23 78, OCS Disconnect Switch Installation.
- B. Install disconnect switches at the locations shown on the Contract Drawings.
- C. Install in accordance with approved manufacturer's instructions.
- D. Provide mounting supports and additional hardware, as required, such as bolts, couplings, bushings, connectors, grounding conductors, and all basic electrical materials for a complete installation.
- E. Installation shall conform to NFPA 70 and IEEE C2.
- F. Operating Handle: Mount at 4 feet above grade or floor.
- G. VMF Disconnect Switches:
 1. Wall mount on specified insulated standoffs.
 2. Provide specified shroud material and enclose switch as indicated on Contract Drawings.
- H. Pad-Mounted Disconnect Switches:
 1. Under the bottom of the enclosure, provide fiberglass framing channel in accordance with Section 34 22 29, TES Raceway and Equipment Hangers and Supports, or other non-corroding spacers to allow drainage from specified condensation drain plug.
 2. Secure each switch enclosure to a concrete pad outside substation, as indicated on Contract Drawings.
 3. Wire to SAS to provide switch status indication, as specified in Section 34 21 31, TES Substation Automation System (SAS), and indicated on Contract Drawings.

3.2 CONNECTION OF CABLES

- A. Provide cable clamps on line and load side of switches to prevent stress on connectors and switch jaws.
- B. Orient bolts securing cable lugs such that they do not reduce the electrical clearance to grounded parts of the switch.

3.3 SUPERVISION BY SWITCH MANUFACTURER

- A. Install first switch under the direct supervision of a qualified representative of the switch manufacturer.
- B. Manufacturer's qualified representative shall certify that each switch is correctly installed and adjusted after installation and before initial energization.

3.4 ENERGIZATION

- A. Demonstrate to the satisfaction of the Engineer final switch positions and correct operation of each switch before energizing OCS.

3.5 PADLOCKS

- A. Quantities:
 - 1. Provide one indoor padlock for each switch in the VMF.
 - 2. Provide one outdoor padlock for each pole-mounted exposed switch.
 - 3. Provide two outdoor padlocks for each pad-mounted and each pole-mounted enclosed switch.
- B. Provide two keys for each padlock.

PART 4 - MEASUREMENT AND PAYMENT**4.1 MEASUREMENT**

- A. The quantities of accepted work will be measured in the following units. All measurements will be plan measure except for authorized changes.
 - 1. Description: Lump Sum

4.2 PAYMENT

- A. Payment will be made at the respective unit or lump-sum price listed in the proposal and shall be full compensation for all labor, materials, and equipment necessary to complete the respective unit in place. There will be no separate measurement or payment for any item of work not specifically identified and listed in the proposal, and all such work shall be considered a subsidiary item with all costs pertaining thereto included in the prices for other items listed in the proposal. At the Engineer's option, partial payment may be made for any lump sum item listed in the proposal, providing that the Contractor is diligently and satisfactorily pursuing full completion of such partially complete item in accordance with the approved job progress schedule.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 34 21 46**TES VMS AC MOTOR CONTROL CENTER (MCC)****PART 1 - GENERAL****1.1 SUMMARY**

- A. This Section includes ac motor control center and related components in Vehicle Maintenance Facility (VMF) TES substation.

1.2 RELATED SECTIONS

- A. SECTION 34 21 06 – TES Common Work Results for Metals
- B. SECTION 34 21 12 – TES Low-Voltage Panelboards
- C. SECTION 34 21 17 – TES Substation Design and Assembly
- D. SECTION 34 21 46 – TES VMS Ac Motor Control Center
- E. SECTION 34 21 80 – TES Spare Parts and Special Tools
- F. SECTION 34 22 05 – TES Common Work Results for Conductors and Cable
- G. SECTION 34 22 10 – TES Low-Voltage Conductors and Cable

1.3 REFERENCED STANDARDS

- A. Section incorporates by reference the latest revisions of the following documents:
- B. National Fire Protection Association (NFPA)
 - 1. NFPA 70, National Electrical Code (NEC)

1.4 SUBMITTALS

- A. Procedures: Section 01 33 00, Submittal Procedures.
- B. Product Data:
 - 1. Submit manufacturers' product data for specified equipment and materials. Include the following information for each item:
 - a. Manufacturer's model number or item identification.
 - b. UL listing and rating.
 - c. Critical dimensions and mounting arrangement.
 - d. Replacement parts list.
- C. Spare Parts and Special Tools:
 - 1. Submit a list of spare parts to be provided under this Section.
 - 2. Submit at the same time as product data.

3. Provide part numbers for each part, including a detailed break down of each spare part assembly and set, as defined in Section 34 21 80, TES Spare Parts and Special Tools.
 4. Submit a list of special tools to be provided under this Section, as defined in Section 34 21 80, TES Spare Parts and Special Tools.
- D. Shop Drawings:
1. Submit shop drawings and electrical diagrams showing materials and methods of construction, bus inside enclosure, door arrangement, breakers, motor starters, disconnects, and indicating lights.
- E. Test Reports:
1. Submit copies of certified reports of factory and field tests performed in accordance with the applicable referenced standards and specification requirements.
- F. Operation and Maintenance Data:
1. Submit manufacturer's operating and maintenance instructions on products specified in this Section, including the following:
 - a. Description, including part number and manufacturer, of MCC, each type of circuit breaker, contactor, relay, control switch, and related components.
 - b. Parts list, illustrations and diagram for components.
 - c. Wiring diagram.

1.5 SPARE PARTS

- A. Provide spare parts in accordance with Section 34 21 80, TES Spare Parts and Special Tools.
- B. List below applies to items in this Specification Section:
1. APS circuit breaker and contactor: Provide 1 spare assembly.
 2. APS control switch: Provide 1 spare.

1.6 QUALITY ASSURANCE

- A. Comply with the requirements of the Project Quality Plan.
- B. Manufacturer's Qualifications:
1. Manufacturer of MCC must be regularly engaged in the manufacture of similar equipment.
 2. Manufacturer of MCC and components used in the dc switchgear must be ISO 9001 certified.
- C. MCC shall be UL labeled or furnished with a Field Evaluation label in accordance with Section 34 21 17, TES Substation Design and Assembly.

PART 2 - PRODUCTS**2.1 AC MOTOR CONTROL CENTER (MCC)****A. General Description:**

1. Provide a free-standing, totally enclosed, dead front structure containing a main circuit breaker, individual enclosed control units, a common bus bar for distributing power to the control units, and wire trough and conductor entrance areas for incoming and outgoing loads and control wires.
2. Each control unit includes a breaker, magnetic motor starter (contactor), and an external disconnect handle.
3. Refer to Contract Drawings for elevation and schematic drawings.
4. Complete assembly shall comply with NFPA 70.

B. MCC Rating: 480 V, 3-phase, 4-wire, 60 Hz unless otherwise indicated.**C. MCC Enclosure:**

1. NEMA Type 12.
2. Steel structure with the following gauges:
 - a. Vertical sections: Minimum 12 gauge.
 - b. Internal structural parts: Minimum 14 gauge.
 - c. Doors: Minimum 14 gauge.
3. Finish: Powder coat in accordance with Section 34 21 06, TES Common Work Results for Metals.
4. Color:
 - a. Exterior: In accordance with Section 34 21 06, TES Common Work Results for Metals.
 - b. Interior back panels: White.

D. MCC Bus Bars: Silver plated copper.**E. APS Motor Starter (Contactor):**

1. Rating: 200 A continuous, 208 Vac, three phase, 60 Hz.
2. Control Voltage: 120 Vac.
3. Auxiliary Contacts: Provide for interlocking.
4. See Section 34 21 46, TES VMS Ac Motor Control Center for APS requirements.

F. Main Circuit Breaker:

1. Thermal magnetic, molded case.
2. Rating: 400 A

- G. APS Circuit Breakers:
1. Thermal magnetic, molded case.
 2. Rating: 200 A.
- H. Branch Circuit Breaker
1. Thermal magnetic, molded case.
 2. Rating: 100 A.
 3. To feed VMS TES substation ac panel; see Section 34 21 12, TES Low-Voltage Panelboards, for ac panel requirements.
- I. Control Wiring:
1. Factory-installed.
 2. Control Power: 120 Vac.
 3. Wire:
 - a. 600 V switchboard wire complying with Section 34 22 10, TES Low-Voltage Conductors and Cable.
 - b. Minimum Size: No. 14 AWG.
 - c. For wiring across hinged joints: Class D stranded wire, minimum size No. 12 AWG.
 4. Wire Terminals: Tinned copper ring compression terminals with insulated sleeve installed in accordance with the manufacturer's recommendations.
 5. Terminal Blocks: In accordance with Section 34 21 17, TES Substation Design and Assembly. Provide a minimum of ten percent spare terminals.
 6. Wire Connections: Make only on terminal blocks.
- J. Control Switches:
1. For each contactor, provide a control switch that complies with Section 34 21 17, TES Substation Design and Assembly.
 2. Mount on each MCC APS control compartment door to turn control power on and off for each contactor.
- K. LED Indication:
1. For each contactor, provide panel mount indicating lights that comply with Section 34 21 17, TES Substation Design and Assembly.
 - a. Red: Contactor closed.
 - b. Green: Contactor open.
 2. Mount on each MCC APS control compartment door to indicate status of each contactor.

2.2 IDENTIFICATION AND WARNING SIGNS

- A. Wire Identification:
1. Provide each wire with plastic heat shrink sleeve, meeting the requirements of Section 34 22 05, TES Common Work Results for Conductors and Cable.
 2. Print with the number indicated on the wiring diagrams.
 3. Attach within 6 inches of terminal connections.
 4. Heat shrink sleeves after installation.
- B. Equipment Identification: Provide equipment and device nameplates on face of panel in accordance with Section 34 21 17, TES Substation Design and Assembly. See Contract Drawings for contactor numbering.
- C. Warning Signs: Provide "DANGER HIGH VOLTAGE" signs on each section door that comply with Section 34 21 17, TES Substation Design and Assembly.

2.3 SOURCE QUALITY CONTROL

- A. In addition to the manufacturer's standard tests, as a minimum perform the following tests at the manufacturer's plant:
1. Electrical operation tests.
 2. Control wiring checks.

PART 3 - EXECUTION

Not Used

PART 4 - MEASUREMENT AND PAYMENT**4.1 MEASUREMENT**

- A. The quantities of accepted work will be measured in the following units. All measurements will be plan measure except for authorized changes.
1. Description: Lump Sum

4.2 PAYMENT

- A. Payment will be made at the respective unit or lump-sum price listed in the proposal and shall be full compensation for all labor, materials, and equipment necessary to complete the respective unit in place. There will be no separate measurement or payment for any item of work not specifically identified and listed in the proposal, and all such work shall be considered a subsidiary item with all costs pertaining thereto included in the prices for other items listed in the proposal. At the Engineer's option, partial payment may be made for any lump sum item listed in the proposal, providing that the Contractor is diligently and satisfactorily pursuing full completion of such partially complete item in accordance with the approved job progress schedule.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 34 21 50

DC SURGE ARRESTERS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Product and installation requirements for dc surge arresters in TES substations.
 - 2. Product requirements for dc surge arresters for OCS.

1.2 RELATED SECTIONS

- A. SECTION 34 21 80 – TES Spare Parts and Special Tools
- B. SECTION 34 21 90 – TES Testing
- C. SECTION 34 22 10 – TES Low-Voltage Conductors and Cable
- D. SECTION 34 22 26 – TES Grounding and Bonding
- E. SECTION 34 23 77 – OCS Surge Arrester Installation

1.3 REFERENCED STANDARDS

- A. Section incorporates by reference the latest revisions of the following documents:
- B. American Society for Testing and Materials (ASTM)
 - 1. ASTM B3, Soft or Annealed Copper Wire
 - 2. ASTM B172, Rope-Lay Stranded Conductors having Bunch Stranded Members
- C. American National Standards Institute (ANSI)
 - 1. ANSI C62.11, Standard for Metal-Oxide Surge Arresters for Ac Power Circuits (> 1 kV)
- D. National Electrical Manufacturer's Association (NEMA)
 - 1. NEMA 250, Enclosures for Electrical Equipment (1000 Volts Maximum)

1.4 SUBMITTALS

- A. Procedures: Section 01 33 00, Submittal Procedures.
- B. Product Data:
 - 1. Descriptive data on the surge arresters to be provided.
 - 2. Shop (installation) drawings to scale showing the surge arrester installation.
- C. Spare Parts and Special Tools:
 - 1. Submit a list of spare parts to be provided under this Section.

- 2. Submit at the same time as product data.
 - 3. Provide part numbers for each part, including a detailed break down of each spare part assembly and set, as defined in Section 34 21 80, TES Spare Parts and Special Tools.
 - 4. Submit a list of special tools to be provided under this Section, as defined in Section 34 21 80, TES Spare Parts and Special Tools.
- D. Submit factory test reports within 30 days after conducting tests:
- 1. Design test reports.
 - 2. Production test reports.

1.5 SPARE PARTS

- A. Provide spare parts in accordance with Section 34 21 80, TES Spare Parts and Special Tools.
- B. List below applies to items in this Specification Section.
 - 1. Dc surge arrester, complete with mounting bracket and minimum 3-foot extra-flexible grounding conductor: Provide 10 spares.

1.6 QUALITY ASSURANCE

- A. Comply with the requirements of the Project Quality Plan.
- B. Manufacturer's Qualifications:
 - 1. Manufacturer shall have minimum 5 years of successful use of its surge arrester at light rail or street car facilities.
 - 2. Excessive failures of the proposed surge arrester at one or more transit facilities disqualifies the product for use on this project.

PART 2 - PRODUCTS

2.1 DC SURGE ARRESTERS

- A. Dc surge arresters shall be outdoor style, intermediate class and shall be designed, constructed, and tested in accordance with the general requirements of ANSI C62.11.
- B. Surge arresters shall be of the metal oxide varistor (MOV) type.
- C. MOV elements shall be fully encapsulated in epoxy.
- D. Minimum conduction voltage: 1000 V.
- E. Energy discharge capability: 2.6 kJ for currents 500 A or less.
- F. Reverse voltage across rectifier silicon diodes: Arresters shall limit to a value less than 75 percent of the peak-reverse-voltage rating of the diode by limiting the rise of the transient on the positive to negative bus.
- G. Acceptable Manufacturer/Supplier: Reuel/Balfour Beatty Rail, Inc., IMP-1, or approved equal.

2.2 GROUNDING CONDUCTOR

- A. Extra-flexible bare cable: Copper, 4/0 AWG, Class I stranding, ASTM B3, ASTM B172.
- B. Insulated cable: Copper, 4/0 AWG, 2 kV rated insulation. Refer to Section 34 22 10, TES Low-Voltage Conductors and Cable, for requirements.
- C. Splice: C-type compression connector, Burndy Hyground or approved equal.

2.3 SOURCE QUALITY CONTROL

- A. Design Testing:
 - 1. Test to Failure:
 - a. Perform test on one surge arrester.
 - b. Install surge arrester in proposed enclosure, or in approved alternate mounting arrangement, complete with cables connected.
 - c. Test to failure at two times energy rating and verify that arc clears and that enclosure does not fail catastrophically.
 - d. If enclosure does not contain the surge arrester failure, submit a new surge arrester, new enclosure, or both, and retest.
- B. Production Testing:
 - 1. Energy Test:
 - a. Test each surge arrester and provide test report.
 - b. Test at 80 percent of rated energy.
 - 2. Voltage Test (minimum requirement; additional tests may be performed):
 - a. Test each surge arrester after completion of the energy test and provide test report.
 - b. Test using a calibrated ac dielectric test set capable of reading leakage values.
 - c. Apply 1000 Vac for 30 seconds. Maximum allowable leakage current 15 mA.
 - d. Increase voltage to 1100 Vac for 5 seconds. Maximum allowable leakage current 30 mA.

2.4 TES SUBSTATION ASSEMBLY

- A. Negative: Provide surge arresters connected between the negative bus and the ground mat.
- B. Positive: Provide surge arresters between the load side of each dc feeder breaker and substation ground as indicated on Contract Drawings.
 - 1. Wall mount surge arresters on insulated brackets on exterior of substation.
 - 2. Mounting Height: Minimum 8 feet to bottom of surge arrester.

- C. Install in accordance with surge arrester manufacturer's instructions and as indicated on Contract Drawings.
- D. Install conductors with a minimum number of bends. Bends shall be no less than 8-inch radius.
- E. Connection of cable to surge arrester on ungrounded side shall be taped and covered with a heat-shrink insulating sleeve to provide an insulation level of 1000 V.
- F. Ground side of surge arrester: Provide extra flexible grounding conductor, minimum length 3 feet.

PART 3 - EXECUTION

3.1 TES SUBSTATION SURGE ARRESTERS

- A. Connect extra-flexible copper ground to ground-mat pigtail.
- B. If ground-mat pigtail is too short, provide cable and splices to connect ground-mat pigtail to substation surge arrester extra-flexible copper ground.

3.2 OCS SURGE ARRESTERS

- A. See Section 34 23 77, OCS Surge Arrester Installation, for installation requirements.

3.3 TESTING SURGE ARRESTER GROUNDS

- A. Test surge arrester grounds in accordance with Section 34 21 90, TES Testing.
- B. See required maximum values for grounds in Section 34 22 26, TES Grounding and Bonding.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

- A. The quantities of accepted work will be measured in the following units. All measurements will be plan measure except for authorized changes.
 - 1. Description: Lump Sum

4.2 PAYMENT

- A. Payment will be made at the respective unit or lump-sum price listed in the proposal and shall be full compensation for all labor, materials, and equipment necessary to complete the respective unit in place. There will be no separate measurement or payment for any item of work not specifically identified and listed in the proposal, and all such work shall be considered a subsidiary item with all costs pertaining thereto included in the prices for other items listed in the proposal. At the Engineer's option, partial payment may be made for any lump sum item listed in the proposal, providing that the Contractor is diligently and satisfactorily pursuing full completion of such partially complete item in accordance with the approved job progress schedule.

END OF SECTION

SECTION 34 21 70**VEHICLE MAINTENANCE FACILITY (VMF) TES CONTROL AND APS****PART 1 - GENERAL****1.1 SUMMARY**

- A. This Section includes the following:
 - 1. Requirements for providing mechanical interlocking for TES equipment in the Vehicle Maintenance Facility (VMF).
 - 2. VMF Emergency Trip Stations (ETS)
 - 3. Requirements for VMF Auxiliary Power Stations (APS)
 - 4. Requirements for ac control power.

1.2 RELATED SECTIONS

- A. SECTION 34 21 17 – TES Substation Design and Assembly
- B. SECTION 34 21 31 – TES Substation Automation System (SAS).
- C. SECTION 34 21 46 – TES VMF Ac Motor Control Center (MCC)

1.3 REFERENCED STANDARDS

- A. Section incorporates by reference the latest revisions of the following documents:
- B. National Electrical Manufacturers Association (NEMA)
 - 1. NEMA 250, Enclosures for Electrical Equipment (1000 Volts Maximum)
- C. National Fire Protection Association (NFPA)
 - 1. NFPA 70, National Electrical Code (NEC)

1.4 SUBMITTALS

- A. Procedures: Section 01 33 00, Submittal Procedures.
- B. Product Data:
 - 1. APS Disconnect Switch.
 - 2. APS Control Panel components.
 - 3. APS cable.
 - 4. APS cable strain relief.
 - 5. APS cable rack.
- C. Shop Drawings:
 - 1. Dimensioned drawings of APS Control Panel with component layout.

2. Schematic and wiring diagrams of interlocking design with narrative description of interlocking.
3. Dimensioned installation drawings showing layout of APS Disconnect Switch, APS Control Panel, and APS cable rack with mounting details and raceway layout.

PART 2 - MATERIALS

2.1 MECHANICAL INTERLOCKING

- A. For interlocking product data requirements, see Contract Drawings.
- B. OCS Disconnect Switches: Key is removable only when switch is in the open position, and switch can be closed only when key is inserted and in the captive position.
- C. APS: Key is removable only when APS disconnect switch is in the open position, and switch can be closed only when key is inserted and in the captive position.

2.2 VMF TES ELECTRICAL INTERLOCKING DESIGN

- A. Design and implement a control and interlocking scheme for VMF TES elements and submit shop drawings with schematic and wiring diagrams. Base design on the following:
 1. VMF ETS and APS Control Schematic in Contract Drawings;
 2. Requirements in this Section;
 3. Requirements in Section 34 21 46, TES VMF Ac Motor Control Center (MCC); and
 4. TES substation manufacturer's detailed design.
- B. Design must include the following:
 1. Emergency Trip Stations (ETS) in VMF Shop.
 2. Auxiliary Power Stations (APS) in VMF Shop.
 3. APS contactors in Ac MCC in VMF TES substation.
 4. Breakers S1-AC1 and S1-F1 in VMF TES substation.

2.3 EMERGENCY TRIP STATIONS IN VMF SHOP

- A. Emergency trip stations are located throughout the Shop so that personnel can quickly shut off OCS power and APS power by depressing one button. For details, see Part 3, below, and VMF ETS and APS Control Schematic in Contract Drawings.
- B. ETS Buttons:
 1. For general requirements, see Section 34 21 17, TES Substation Design and Assembly.
 2. Latching with twist release.
- C. Protective Cover: Section 34 21 17, TES Substation Design and Assembly.
- D. Enclosure: NEMA 250 Type 4.

2.4 AUXILIARY POWER STATIONS

- A. Auxiliary power stations are used to provide power to streetcars in the Shop without energizing the OCS. The following elements are involved, as shown in Contract Drawings:
1. Ac Motor Control Center (MCC): Located in the VMS substation. Each APS is fed from a circuit breaker and contactor in the Ac MCC. See Section 34 21 46, TES VMF Ac Motor Control Center (MCC) and Contract Drawings.
 2. APS Disconnect Switch: Located on the Shop floor adjacent to the APS Control Box. Each one is fed from a contactor in the Ac MCC. See below, and in Contract Drawings.
 3. APS Control Cabinet: Located on the Shop floor adjacent to the APS Disconnect Switch. This is fed from the APS Disconnect Switch and has pushbuttons for controlling power, indicating lights, and an APS cable attached to it. See below, and in Contract Drawings.
 4. APS Cable ("Stinger"): This is coiled up adjacent to the APS Control Cabinet when not in use, and when in use connects to the streetcar. See below, and in Contract Drawings.
 5. Interlocks:
 - a. Mechanical: The APS is mechanically interlocked with the OCS Disconnect Switch in the same bay such that both cannot be energized at the same time. See Mechanical Key Interlocking Scheme in Contract Drawings.
 - b. Electrical: The APS cable attachment plug is interlocked with the APS Control Cabinet such that the contactor in the MCC will open if the attachment plug is inserted or withdrawn from the streetcar receptacle with the APS energized. See VMF ETS and APS Control Schematic in Contract Drawings.
- B. Wiring and assembly of Ac MCC, APS disconnect switch, APS control cabinet, and APS cable with attachment plug shall comply with NFPA 70.
- C. APS Disconnect Switch:
1. Heavy duty, three phase, with auxiliary contacts for switch position indication, and mechanical interlock installed, as described above.
 2. Suitable for mounting on wall or post.
 3. Nameplate as specified in Section 34 21 17, TES Substation Design and Assembly, and as indicated on Contract Drawings.
- D. APS Control Cabinet:
1. Enclosure: Stainless steel, NEMA 250 Type 12, hinged cover, with white-painted back panel, suitable for mounting on wall or post.
 2. Configuration as indicated on Contract Drawings.
 3. Control Power: 120 Vac.

4. Indicating lights:
 - a. NEMA 250 Type 12, and as specified in Section 34 21 17, TES Substation Design and Assembly.
 - b. Color: As indicated on Contract Drawings.
 5. Pushbuttons: NEMA 250 Type 12, and as specified in Section 34 21 17, TES Substation Design and Assembly, for trip and close.
 6. Terminal blocks: As specified in Section 34 21 17, TES Substation Design and Assembly
 7. Nameplates: As specified in Section 34 21 17, TES Substation Design and Assembly, and as indicated on Contract Drawings.
- E. APS Cable ("Stinger"):
1. Jacket: Heavy duty, polyurethane oil and water resistant, Leoni L-FLEXX 290 P or approved equal.
 2. Conductors: 600 V, three 2/0 AWG stranded copper power conductors, one 2/0 AWG neutral, one #6 AWG ground, and two #12 AWG interlock control wires.
 - a. Confirm with streetcar manufacturer the electrical load and size of receptacle and matching attachment plug before ordering cable. Cable and overcurrent protection must be sized for actual load.
 - b. Confirm with streetcar manufacturer whether or not neutral conductor is required before procuring cable.
 3. Strain relief: Stainless steel wire mesh type, with stainless steel threaded end and locknut, suitable for knockout mounting.
 4. Attachment Plug: Compatible with receptacle on streetcar. See Contract Drawings and confirm with streetcar manufacturer before procuring.
 5. Cable Rack: Heavy duty, stainless steel or painted hot-dip galvanized steel, suitable for coiling the entire length of APS cable adjacent to APS Control Cabinet.

2.5 AC CONTROL POWER

- A. Ac Control Power shall be from the VMS TES substation Ac Panel.
- B. Provide an undervoltage alarm (Device 127) for each ac control circuit.
 1. If a circuit from the ac panel feeds downstream mini circuit breakers, each of the circuits controlled by a mini circuit breaker is considered a control circuit for the purposes of this requirement.
 2. Provide alarm to SAS; see Section 34 21 31, TES Substation Automation System (SAS).

PART 3 - EXECUTION

3.1 EMERGENCY TRIP STATIONS (ETS) IN VMF SHOP

- A. Provide specified ETSs in Shop where indicated on Contract Drawings.

- B. Wire ETSs in series, as indicated on Contract Drawings, using ac control power circuit from ac panel in VMS TES substation.
- C. Connect Shop ETS circuit to VMS TES substation to trip and lockout substation main ac breaker, dc feeder breaker, and to open the two APS contactors in Ac MCC. See VMF ETS and APS Control Schematic in Contract Drawings.

3.2 AUXILIARY POWER STATION (APS)

- A. Provide two APSs, in locations indicated on Contract Drawings.
- B. Coordinate wall or post mounting with Engineer.
- C. Provide sufficient APS cable for finished length of 30 feet measured from edge of control box to end of cord cap, or a length to reach the APS receptacle on the streetcar vehicle plus 10 feet, whichever is greater.
- D. Connect APS cable to APS Control Cabinet using specified strain relief.
- E. Connect attachment plug to APS cable.
- F. Provide APS rack adjacent to APS Control Cabinet. Mount securely at a suitable height such that cable can be neatly coiled on the rack when not in use.
- G. Connect each APS Disconnect Switch to its respective contactor in the Ac MCC in the VMS TES substation, as indicated on Contract Drawings.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

- A. The quantities of accepted work will be measured in the following units. All measurements will be plan measure except for authorized changes.
 - 1. Description: Lump Sum

4.2 PAYMENT

- A. Payment will be made at the respective unit or lump-sum price listed in the proposal and shall be full compensation for all labor, materials, and equipment necessary to complete the respective unit in place. There will be no separate measurement or payment for any item of work not specifically identified and listed in the proposal, and all such work shall be considered a subsidiary item with all costs pertaining thereto included in the prices for other items listed in the proposal. At the Engineer's option, partial payment may be made for any lump sum item listed in the proposal, providing that the Contractor is diligently and satisfactorily pursuing full completion of such partially complete item in accordance with the approved job progress schedule.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 34 21 73**TES STUDIES****PART 1 - GENERAL****1.1 SUMMARY**

- A. This Section includes requirements for the following computer-based studies and reports for ac and dc switchgear associated with TES substations:
1. Short-circuit study.
 2. Ac coordination study.
 3. Dc coordination study.
 4. Arc-flash hazard analysis study.

1.2 REFERENCED STANDARDS

- A. Section incorporates by reference the latest revisions of the following documents:
- B. American National Standards Institute (ANSI):
1. ANSI Z535.4, Standard for Product Safety Signs and Labels
- C. Institute of Electrical and Electronics Engineers (IEEE):
1. IEEE 241, Recommended Practice for Electric Power Systems in Commercial Buildings
 2. IEEE 242, Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems
 3. IEEE 399, IEEE Recommended Practice for Power Systems Analysis
 4. IEEE 1015, Recommended Practice for Applying Low-Voltage Circuit Breakers Used in Industrial and Commercial Power Systems
 5. IEEE 1584, Guide for Arc Flash Hazard Calculations
 6. IEEE C37.20.1, Standard for Metal-Enclosed Low-Voltage Power Circuit Breaker Switchgear
 7. IEEE C37.46, Standard Specifications for High Voltage (> 1000 V) Expulsion and Current-Limiting Type Power Class Fuses and Fuse Disconnecting Switches
 8. IEEE C57.96, Guide for Loading Dry-Type Distribution and Power Transformers
- D. Insulated Cable Engineers Association (ICEA)
1. ICEA P-32-382, Short Circuit Characteristics of Insulated Cable
 2. ICEA P-45-482, Short-Circuit Performance of Metallic Shielding and Sheaths

- E. National Electrical Manufacturer's Association (NEMA)
 - 1. NEMA MG 1, Motors and Generators
- F. National Fire Protection Association (NFPA)
 - 1. NFPA 70, National Electrical Code
 - 2. NFPA 70E, Standard for Electrical Safety in the Workplace

1.3 SUBMITTALS

- A. Procedures: Section 01 33 00, Submittal Procedures.
- B. Product Data: Computer software to be used for system simulation.
- C. Product Certificates:
 - 1. For short-circuit and overcurrent protective device coordination study, provide certification of compliance with IEEE 399.
 - 2. For arc-flash hazard analysis, provide certification of compliance with IEEE 1584.
- D. Qualifications: Submit names, contact information and qualifications including references for at least five short-circuit, coordination study and arc-flash calculations of comparable complexity within the last five years.
- E. Provide the following reports for each substation:
 - 1. Input data including completed computer program input data sheets.
 - 2. Short-Circuit Study and Equipment Evaluation Reports.
 - 3. Ac Coordination Study Report: Submit at the same time as Dc Coordination Study Report.
 - 4. Dc Coordination Study Report.
 - 5. Arc Flash Hazard Analysis Report.

1.4 QUALITY ASSURANCE

- A. Comply with the requirements of the Project Quality Plan.
- B. Studies shall use computer programs that are distributed nationally and are in wide use.
 - 1. Software algorithms shall comply with requirements of standards and guides specified in this Section.
 - 2. Manual calculations or calculations using spreadsheet software are not acceptable.
- C. Study Specialist Qualifications:
 - 1. Analysis and reports shall be prepared by an individual experienced in the application of computer simulations to traction power systems.
 - 2. Qualifications shall be submitted for approval and shall document that the individual has at least five years experience and has prepared five studies of comparable complexity.

3. Analysis and reports shall be supervised and signed by a professional electrical engineer licensed in the State of Missouri.
- D. Studies, analysis, and reporting shall comply with the following standards:
1. IEEE 241 and 242 for short-circuit and coordination analysis.
 2. IEEE 399 for general study procedures.
 3. IEEE 1584 and NFPA 70E for arc-flash hazard analysis.
 4. NFPA 70.

PART 2 - PRODUCTS

2.1 SIMULATION SOFTWARE

- A. Acceptable Software: Subject to approval, simulation software shall be the product of one of the following developers.
1. CGI CYME
 2. EDSA Micro Corporation
 3. ESA Inc.
 4. Operation Technology, Inc.
 5. SKM Systems Analysis Inc.

2.2 SOFTWARE REQUIREMENTS

- A. Computer software for short-circuit study shall include analytical features described in IEEE 399 as Mandatory, Very Desirable, and Desirable.
- B. Computer software:
1. Shall be capable of plotting and diagramming time-current characteristic curves as part of the output.
 2. Shall report device settings and ratings of all overcurrent protective devices.
 3. Shall demonstrate selective coordination by computer-generated, time-current coordination plots using different colors for each protective device.

PART 3 - EXECUTION

3.1 DATA COLLECTION AND COORDINATION

- A. Collect data from equipment suppliers, other contractors or subcontractors, Kansas City Power & Light and the Owner in order to complete the analysis.
- B. Coordinate required distribution equipment ratings and protective device settings to provide a fully-integrated distribution system that is properly coordinated and meets the requirements of NFPA 70. Proceed with final analysis only after relevant equipment has been finally determined and submittal information is sufficient to produce accurate simulation results.

3.2 SYSTEM DOCUMENTATION

- A. Collect and tabulate the following input data to support studies.
1. Product data for overcurrent protective devices including devices furnished by others and involved in overcurrent protection.
 2. Resistance and reactance data and fault current data from serving utility.
 3. Electrical Distribution System Diagram. Provide documentation in both paper and electronic formats for the following:
 - a. Circuit breaker and fuse current ratings and types.
 - b. Relays and associated power and current transformer ratings and ratios.
 - c. Transformer ratings including kVA ratings for each cooling type, primary and secondary voltages, connection type, transformer impedance, and X/R ratios. Provide information on transformer over-temperature sensors provided.
 - d. Cable information including number in parallel, conductor material, compaction, sizes, insulation type and temperature ratings, and cable length.
 - e. Busway material, ampacity, and impedance.
 - f. Motor horsepower, full-load current and code letter according to NEMA MG 1.
 4. Equipment data sheets:
 - a. Special load considerations including starting inrush currents and frequent starting.
 - b. Transformer characteristics, including primary protective device recommendations, inrush current, and thermal damage curve.
 - c. Motor full-load current, locked-rotor current, service factor, starting time, type of starter, and thermal damage curve.
 - d. Utility protective device types, ratings and relay settings.
 - e. Special overcurrent protective device settings or types if required by the serving utility.
 - f. Time-current characteristic curves of devices to be coordinated.
 - g. Circuit breaker manufacturer, frame size, interrupting capacity, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range.
 - h. Overcurrent relay manufacturer, type, ampere tap range, time-delay range, instantaneous range, and current transformer ratio.
 - i. Panelboard and switchboard, ampere rating and interrupting rating.
- B. Use equipment identification tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.

3.3 SHORT-CIRCUIT STUDY

- A. Calculate maximum available fault current in amperes rms symmetrical at overcurrent protective device positions throughout the electrical distribution system. Calculation shall be for current immediately after initiation of a three-phase bolted fault at each of the following:
 - 1. Switchgear and switchboard bus.
 - 2. Distribution panelboard.
 - 3. Branch circuit panelboard.
- B. Analyze the electrical distribution system from normal and alternate power sources throughout electrical distribution system. Include studies of system switching configurations and alternate operations that could result in maximum fault condition.
- C. Calculate momentary and interrupting duties on the basis of maximum available fault current.
- D. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with IEEE 241 and IEEE 242.
 - 1. For transformer, comply with IEEE C57.96.
 - 2. For low-voltage circuit breakers, comply with IEEE 1015 and IEEE C37.20.1.
 - 3. For low-voltage fuses, comply with IEEE C37.46.
- E. Final Report
 - 1. Indicate calculated X/R ratios and equipment (half-cycle) fault currents on electrical one-line diagram.
- F. Equipment Evaluation Report
 - 1. Overcurrent Protective Devices: Ensure that interrupting ratings are equal to or higher than calculated available half-cycle symmetrical fault current.
 - 2. Devices and equipment rated for asymmetrical fault current: Apply multipliers listed in the Standards to half-cycle symmetrical fault current.
 - 3. Conductors:
 - a. Verify adequacy of phase conductors at maximum three-phase bolted fault currents.
 - b. Verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents.
 - c. Ensure that short-circuit withstand ratings are equal to or higher than calculated half-cycle symmetrical fault currents.

3.4 AC COORDINATION STUDY

- A. Perform coordination study using approved computer software. Prepare a written report using results of short-circuit study. Comply with IEEE 399.
 - 1. Calculate the maximum and minimum half-cycle short-circuit currents.

2. Calculate the maximum and minimum ground-fault currents.
- B. Comply with IEEE 241 and IEEE 242 recommendations for fault currents and time intervals.
- C. Transformer Primary Overcurrent Protective Devices:
1. Devices shall not operate in response to the following:
 - a. Transformer magnetizing inrush currents.
 - b. Self-cooled, full-load current or forced-air-cooled, full-load current, as appropriate. For transformer equipped for future fan cooling option, overcurrent protective devices shall be capable of resetting to the higher forced-air-cooled rating.
 - c. Permissible transformer overloads according to IEEE C57.96 if required by expected loading or emergency conditions.
- D. Conductor Protection:
1. Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and conductor melting curves in IEEE 242.
 2. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary protection or total clearing time of the fuse.
 3. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.
- E. Coordination Study Report: Prepare a written report including the following:
1. A table with settings selected for overcurrent protective devices including:
 - a. Device identification tag.
 - b. Current transformer ratios and relay curve, tap, time-dial and instantaneous pickup settings.
 - c. Circuit breaker sensor rating and long-time, short-time and instantaneous trip settings.
 - d. Fuse type and current rating.
 - e. Ground-fault relay pickup and time-delay settings.
 2. Coordination Curves:
 - a. Provide documentation of settings of overcurrent protective devices to achieve selective coordination.
 - b. Provide time-current curves to graphically illustrate that adequate time separation exists between devices installed in series, including utility upstream devices.
 - c. Prepare separate sets of curves for the switching schemes and for emergency periods where the power is fed from an alternate source.

- d. Include the following information:
 - 1) Device identification tag
 - 2) Time and current multipliers for curves.
 - 3) Three-phase and line-to-ground damage points for each transformer.
 - 4) No damage, melting, and clearing curves for fuses.
 - 5) Cable damage curves
 - 6) Transformer inrush points.
 - 7) Maximum fault-current cutoff point.
3. Prepare and include in study completed data sheets for setting of overcurrent protective devices.
4. Graphs shall be plotted in both distinctive colors and line styles for each time-current characteristic and damage curve so that black-and-white copies of graphs are still understandable.
5. Provide both bound color copies and color electronic files in PDF format for report.

3.5 DC COORDINATION STUDY

- A. Include the following as a minimum:
 1. Dc bolted positive to negative and positive to ground fault calculations.
 2. Protective device range and setting calculations showing basis for each recommended relay setting.
 3. Plots of rectifier design capability with actual margin of coordination (from breaker trip to design capability) clearly indicated at each of 100, 150 and 200 percent full-load current and short-circuit current.

3.6 ARC-FLASH HAZARD ANALYSIS

- A. Perform Arc-Flash Hazard Analysis with the aid of computer software intended for this purpose.
- B. Perform analysis in conjunction with short-circuit and coordination studies.
- C. Submit the results of the analysis in a table and include device or bus identification tag, bolted fault and arcing fault current levels, flash protection boundary, distances, personal-protective equipment classes and arc-flash incident energy (AFIE) levels.
- D. Perform the analysis under worst-case fault conditions, and describe in the final report when applicable, how these conditions differ from worst-case bolted fault conditions.
- E. Provide self-adhesive equipment labels in compliance with ANSI Z535.4 to document arc flash hazard and required personal protective equipment.

PART 4 - MEASUREMENT AND PAYMENT**4.1 MEASUREMENT**

A. The quantities of accepted work will be measured in the following units. All measurements will be plan measure except for authorized changes.

1. Description: Lump Sum

4.2 PAYMENT

A. Payment will be made at the respective unit or lump-sum price listed in the proposal and shall be full compensation for all labor, materials, and equipment necessary to complete the respective unit in place. There will be no separate measurement or payment for any item of work not specifically identified and listed in the proposal, and all such work shall be considered a subsidiary item with all costs pertaining thereto included in the prices for other items listed in the proposal. At the Engineer's option, partial payment may be made for any lump sum item listed in the proposal, providing that the Contractor is diligently and satisfactorily pursuing full completion of such partially complete item in accordance with the approved job progress schedule.

END OF SECTION

SECTION 34 21 75

TE SYSTEM ASSURANCE

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes developing and implementing a Systems Assurance Program for this Contract, encompassing system safety and reliability engineering to accomplish the following:
1. Avoid, eliminate or reduce potential identified hazards at the early stage of the project life.
 2. Control and minimize hazards to passengers, personnel, and public.
 3. Incorporate fail-safe design principle if possible.
 4. Use high reliability and predictable failure modes components.
 5. Support for the Owner's Safety Certification Program.

1.2 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the following documents:
- B. U.S. Department of Transportation, Federal Transit Administration
1. DOT-FTA-MA-26-5005-00-01, Hazard Analysis Guidelines for Transit Projects
<http://www.fta.dot.gov/documents/HAGuidelines.pdf>
 2. DOT-FTA-MA-90-5006-02-01, Handbook for Transit Safety and Security Certification
<http://transit-safety.volpe.dot.gov/publications/safety/SafetyCertification/pdf/SSC.pdf>

1.3 SUBMITTALS

- A. Qualifications:
1. Resume for each proposed person preparing required submittals.
 2. Samples of similar documents prepared by each proposed person for previous projects.
- B. Proposed Software: Product data, list of projects where used, sample output.
- C. System Safety Program Plan (SSPP):
1. Submit the following hazard analyses included in the SSPP in compliance with DOT-FTA-MA-26-5005-00-01:
 - a. Preliminary Hazard Analysis (PHA).
 - b. Fault Tree Analysis (FTA).
 - c. Failure Mode Effect and Criticality Analysis (FMECA).

- d. Operating Hazard Analysis (OHA).
2. For each hazard analysis, include either separate sections or submit separate submittals for each Systems subsystem:
 - a. Traction electrification cabling.
 - b. TES substations
 - c. VMF interlocking.

1.4 QUALITY ASSURANCE

- A. Comply with the requirements of the Project Quality Plan.
- B. Qualifications:
 1. Documents required in this Section shall be prepared by persons with a minimum of 5-years experience preparing comparable documents for the transit industry.
 2. Persons preparing documents for each Systems subsystem shall be experienced in that subsystem.
 3. Provide samples of documents from previous projects that demonstrate familiarity with the process and subject matter.
- C. Software:
 1. Prepare required documents using recognized industry analysis software.

PART 2 - PRODUCTS

2.1 SYSTEM SAFETY PROGRAM PLAN (SSPP)

- A. The SSPP is designed to eliminate and/or control identified hazards. Include the following hazard analyses prepared in accordance with the guidelines in DOT-FTA-MA-26-5005-00-01:
- B. The SSPP is designed to identify and eliminate hazards where possible, and where not possible, to control identified hazards.
- C. Prepare the following safety analyses in accordance with the guidelines in DOT-FTA-MA-26-5005-00-01. Conform to the schedule in DOT-FTA-MA-26-5005-00-01.
 1. Preliminary Hazard Analysis (PHA): Perform during the concept-planning phase.
 2. Failure Mode Effect and Criticality Analysis (FMECA): Perform during preliminary design so that identified changes can be incorporated into the final design. Update during the commissioning and integrated testing phase if additional hazards are identified.
 3. Fault Tree Analysis (FTA): Perform at the beginning of final design.
 4. Operating Hazard Analysis (OHA): Perform during the latter portion of final design. Update during the commissioning and integrated testing phase if additional hazards are identified.

PART 3 - EXECUTION**3.1 IMPLEMENTATION OF SYSTEM SAFETY**

- A. After completion of required safety submittals, implement changes required to eliminate or mitigate hazards, at no cost to the Owner:
 - 1. Change design if necessary to eliminate identified hazards.
 - 2. Where hazards cannot be eliminated, include safety devices and warning devices in design to mitigate hazards.
 - 3. If an identified hazard can be mitigated only by procedures and training, identify specifically where the hazard has been addressed in training program and Operation and Maintenance Manuals.

3.2 SAFETY CERTIFICATION PROGRAM

- A. The Owner may comply with FTA guidelines to implement a Safety Certification Program (reference DOT-FTA-MA-90-5006-02-01).
- B. Support the Owner's implementation of the program as directed by Engineer.
- C. Participation includes activities such as assisting the Owner with development of checklists and documentation, identifying submittals that satisfy requirements of the Certifiable Item List, providing standards to which components are designed and tested, and identifying safety-related instructions in training and maintenance documents.

PART 4 - MEASUREMENT AND PAYMENT**4.1 MEASUREMENT**

- A. The quantities of accepted work will be measured in the following units. All measurements will be plan measure except for authorized changes.
 - 1. Description: Lump Sum

4.2 PAYMENT

- A. Payment will be made at the respective unit or lump-sum price listed in the proposal and shall be full compensation for all labor, materials, and equipment necessary to complete the respective unit in place. There will be no separate measurement or payment for any item of work not specifically identified and listed in the proposal, and all such work shall be considered a subsidiary item with all costs pertaining thereto included in the prices for other items listed in the proposal. At the Engineer's option, partial payment may be made for any lump sum item listed in the proposal, providing that the Contractor is diligently and satisfactorily pursuing full completion of such partially complete item in accordance with the approved job progress schedule.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 34 21 80**TES SPARE PARTS AND SPECIAL TOOLS****PART 1 - GENERAL****1.1 SUMMARY**

- A. This Section includes the following:
 - 1. Requirements for providing spare parts indicated in other Sections.
 - 2. Requirements for providing maintenance equipment.

1.2 DEFINITIONS

- A. Assembly: A unit consisting of components or parts that have been fitted together to form a self-contained device or fixture.
- B. Set: The quantity of the stated part that is provided as part of one substation. For example, if the part is "LEDs for Dc Switchgear," and 1 substation has 2 red LEDs, 2 green LEDs, and 1 white LED for Dc Switchgear, then 4 sets consists of 8 red LEDs, 8 green LEDs, and 4 white LEDs.

1.3 SUBMITTALS

- A. Procedures: Section 01 33 00, Submittal Procedures.
- B. Submit all items described below a minimum of 90 days before delivery of first spare parts:
 - 1. Comprehensive list of mandatory spare parts. Include spare parts listed in each section of these Specifications that contains a spare parts requirement. List by Specification section.
 - 2. Comprehensive list of mandatory special tools for each TES substation.
 - 3. List of additional recommended spare parts, special tools, and test and maintenance equipment. List separately the recommended special tools, test, and maintenance equipment that can be shared by substations.
 - 4. Provide part numbers for each part, including a detailed break-down of each spare part assembly and set.
 - 5. Provide a price for each part that can be purchased separately, effective for 1 year after notice to proceed.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Schedule: Delivery of spare parts shall be complete a minimum of 60 days before initial energization of the first segment of OCS.
- B. Notice and Shipping List: Provide Engineer notice of delivery and a complete shipping list a minimum of 10 days before delivery. Shipping list shall include the following:
 - 1. Quantity of each part.
 - 2. Manufacturer's part number.

3. Serial number, if applicable.
 4. Description.
 5. Spaces for inserting date of delivery, signature of Contractor, and signature of Engineer.
- C. Authorization: Spare parts shall not be shipped until authorized by Engineer.
- D. Location: Deliver spare parts to a location in greater Kansas City, Missouri metropolitan area designated by the Engineer.
- E. Packaging: Package and label spare parts in moisture-proof containers suitable for shipment and storage. Attach copies of shipping list in the package and to the exterior of the package.
- F. Unloading: Unload spare parts in a manner that will prevent damage to the packages and the contents.
- G. Inspection:
1. Engineer will open the packages and inspect spare parts for damage. Damaged parts will be returned to Contractor and shall be replaced with undamaged parts and materials at no additional expense to the Owner.
 2. Assist Engineer in verifying quantity of parts.
 3. Sign shipping list with quantities verified, obtain Engineer's signature, and date. Engineer will retain the signed shipping list.

PART 2 - PRODUCTS

2.1 REPLACEMENT PARTS

- A. Mandatory Spare Parts:
1. Provide quantity and type of spares specified in each Specification Section. Supply of a spare from one Section does not satisfy the requirement for an identical spare specified in a different Section.
 2. Spare parts shall be identical to those submitted for approval and provided in substations.
 3. Unit price: Include on the submitted mandatory and recommended spare parts lists a price for each item that can be purchased separately, effective for 1 year after notice to proceed.
- B. Spare Parts for Warranty Repairs:
1. The capital spare parts or the spare parts ordered by the Owner for support of operations are not to be used by the Contractor for warranty repairs and warranty parts replacements. Engineer will not be responsible for receiving or storing any parts for warranty support.
 2. At the end of the warranty period, the Owner may consider a negotiated price for purchase of parts stocked by the Contractor for warranty support.

- C. Availability of Replacement Parts:
 - 1. Guarantee parts availability for a period of 10 years from Contract award.
 - 2. Provide detailed manufacturing drawings to the Owner at the end of the 10-year period or when the availability of parts ceases after that date.

2.2 MANDATORY SPECIAL TOOLS

- A. Special tools include but are not limited to fixtures, equipment, gages, hand tools, power tools, motors, or other tools and equipment necessary to troubleshoot, maintain, repair, overhaul, assemble, disassemble, and adjust the TES substation and other elements of the traction electrification system that are not commonly available from commercial tool suppliers.
- B. Provide one set of special tools for each substation and one set for the traction electrification system.

2.3 RECOMMENDED SPARE PARTS AND SPECIAL TOOLS

- A. Provide list of recommended spare parts including description, break down, part number, recommended quantity, and unit price.
- B. Provide list of recommended special tools, test, and maintenance equipment. The Owner may or may not exercise purchase of the recommended items.

PART 3 - EXECUTION

Not Used

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

- A. The quantities of accepted work will be measured in the following units. All measurements will be plan measure except for authorized changes.
 - 1. Description: Lump Sum

4.2 PAYMENT

- A. Payment will be made at the respective unit or lump-sum price listed in the proposal and shall be full compensation for all labor, materials, and equipment necessary to complete the respective unit in place. There will be no separate measurement or payment for any item of work not specifically identified and listed in the proposal, and all such work shall be considered a subsidiary item with all costs pertaining thereto included in the prices for other items listed in the proposal. At the Engineer's option, partial payment may be made for any lump sum item listed in the proposal, providing that the Contractor is diligently and satisfactorily pursuing full completion of such partially complete item in accordance with the approved job progress schedule.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 34 21 90**TRACTION ELECTRIFICATION SYSTEM (TES) TESTING****PART 1 - GENERAL****1.1 SUMMARY**

- A. This Section includes the following:
 - 1. General testing requirements.
 - 2. Factory Acceptance Testing TES substation and its components.
 - 3. Field Acceptance Testing TES substation and its components.
 - 4. Field testing TES system.
 - 5. Other test requirements appear in other Sections.
- B. The requirements of this Section apply to all Division 34 21 xx and 34 22 xx Sections.

1.2 RELATED SECTIONS

- A. SECTION 34 21 05 – Common Work Results for TES
- B. SECTION 34 21 15 – TES Lighting
- C. SECTION 34 21 19 – TES Dc Switchgear.
- D. SECTION 34 21 25 – TES Dc Control Power
- E. SECTION 34 21 31 – TES Substation Automation System (SAS)
- F. SECTION 34 21 33 – TES Rail Voltage Monitoring and Grounding System
- G. SECTION 34 21 70 – VMF TES Control and APS
- H. SECTION 34 22 26 – TES Grounding and Bonding

1.3 REFERENCED STANDARDS

- A. Section incorporates by reference the latest revisions of the following documents:
- B. Institute of Electrical and Electronics Engineers (IEEE)
 - 1. IEEE 80, IEEE Guide for Safety in Ac Substation Grounding
 - 2. IEEE 81, Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System
 - 3. IEEE 400, Guide for Field Testing and Evaluation of the Insulation of Shielded Power Cable Systems
 - 4. IEEE 1187, Recommended Practice for Installation Design and Installation of Valve-Regulated Lead-Acid Batteries for Stationary Applications

5. IEEE 1188 Recommended Practice for Maintenance, Testing, and Replacement of Valve-Regulated Lead-Acid (VRLA) Batteries for Stationary Applications
 6. IEEE C37.20.1, Standard for Metal-Enclosed Low-Voltage Power Circuit Breaker Switchgear
 7. IEEE C37.20.2, Standard for Metal-Clad Switchgear
 8. IEEE C37.41, Standard Design Tests for High-Voltage (> 1000 V) Fuses, Fuse and Disconnecting Cutouts, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches, and Accessories Used with These Devices
- C. InterNational Electrical Testing Association (NETA)
1. NETA ATS, Acceptance Testing Specifications for Electric Power Distribution Equipment and Systems
- D. National Electrical Manufacturers Association (NEMA)
1. NEMA PE 5, Utility-Type Battery Chargers

1.4 FAILURE OF TEST

- A. If any test fails, make corrections and retest at no additional cost to the Owner.
- B. If off-site test is witnessed by Engineer or his representatives and fails, Contractor shall pay for return trip to facility or test site(s) including air fare and lodging.
- C. In the event equipment is not ready for testing by Contractor upon agreed testing date and Engineer or his representatives arrive at test site, Contractor shall pay for return air fare and lodging of Engineer or his representatives.

1.5 SUBMITTALS

- A. Procedures: Section 01 33 00, Submittal Procedures.
- B. Test program plan: Submit within 120 Days after NTP and provide monthly updates.
- C. Test procedures:
 1. Submit a minimum of 60 Days before test is scheduled to be performed.
 2. Tests shall not be performed and test reports will not be considered valid until procedures are approved by Engineer.
- D. Test reports:
 1. Submit within 30 calendar days after completion of each test unless otherwise indicated.
 2. Factory Design Test Reports:
 - a. Submit existing test reports 90 calendar days before shipping equipment.
 - b. Equipment shall not be shipped until the report is approved by the Engineer.
 3. Factory Production Test Reports: For each test specified in this Section.

4. Submit Electrically Insulated Floor and Wall Test Report for each substation before installing substation equipment:
5. Wire and cable testing report: Cable insulation test for dc feeder cables.
6. TES Substation Factory Acceptance Test Report.
7. Submit TES Substation Ground Grid Test report before starting Field Acceptance Test.
8. TES Substation Field Acceptance Test Reports.
9. Pretest TES Substation Factory Acceptance Test Report.
10. Pretest TES Substation Field Acceptance Test Report.
11. Integrated Testing Test Reports:
 - a. Rail Voltage Monitoring and Grounding Devices Tests.
 - 1) Initial chart recording.
 - 2) Final record chart recording.
 - b. Short Circuit Test.
 - c. Train Start Tests.

1.6 REQUIREMENTS FOR TEST PROGRAM PLAN, TEST PROCEDURES, AND TEST REPORTS

- A. Test Program Plan:
 1. Identify each test by reference to the Section, Article, and Paragraph number of the appropriate Technical Section of these Specifications.
 2. Provide a detailed schedule showing the time and place of each test to be performed.
 3. Tests to be included:
 - a. Each test described in this Section and in other Contract Specification Sections, including a test for each substation equipment type or assembly.
 - b. Supplier and Subcontractor tests to be completed at the suppliers' or Subcontractors' plants.
 - c. Contractor's tests to be completed at its plant or approved independent testing lab prior to delivery.
 - d. Other tests conducted by Contractor in connection with its own Quality Assurance program.
- B. Test Procedures: Develop detailed test procedures for each test containing the following:
 1. Title of test.
 2. Contract Specifications Section, Article, and Paragraph number.
 3. Test location.

-
4. Name of the agency performing each test (Contractor, its supplier, or an independent testing company).
 5. Test objective.
 6. Equipment and instrumentation requirements including manufacturer's name, model number, and serial number.
 7. Personnel requirements.
 8. Attached copies of applicable portions of ANSI, IEEE, or NEMA standards. Obtain permission of copyright holder to reproduce the necessary portions of standards and pay copyright holder if required.
 9. Test methodology including test setup, with circuit diagrams and test sequence.
 10. A step-by-step procedure for performing the test, including all steps required for each device tested, even if devices are identical. For example, if there are four circuit breakers to test, provide a separate step-by-step procedure for each breaker.
 11. Forms for recording test data:
 - a. May be incorporated into step-by-step procedure.
 - b. Include space for test equipment calibration data.
 - c. Include a step-by-step format for data reduction and formulas used in deriving the format.
 - d. Include criteria for acceptability and justification for the criteria set forth, including procedures for evaluating data.
 - e. Include space for signatures of test witnesses.
 12. Expected test results.
 13. Test evaluation procedures.
 14. Proposed test report form.
- C. Test Reports:
1. Each test report shall have attached the related and approved test procedure.
 2. Each report shall document the test results obtained and shall include the following information:
 - a. Title of test.
 - b. Contract Specifications Section and Article number.
 - c. Test objectives.
 - d. Summary and conclusions including Pass/Fail or N/A.
 - e. Test location, date, and time.

- f. List of test equipment used, including the following for each piece of test equipment:
 - 1) Manufacturer's name.
 - 2) Model number.
 - 3) Serial number.
 - 4) Calibration certificate showing that equipment was calibrated by an independent agency within the previous 12 months.
- g. Conditions of test, including temperature and humidity.
- h. Raw test data from the approved test procedure forms.
- i. Summarized test data including tables, curves, photographs and any additional test data required to support the test results.
- j. Test results in a form that can easily be compared to these Specifications requirements.
- k. Descriptions of equipment and material failures, and reasons for the failure.
- l. Descriptions of all modifications to equipment or wiring performed during testing, reasons for modifications, and names of individuals approving such modifications.
- m. Abbreviations and references.
- n. Signatures of tester and test witnesses.

1.7 WITNESSING OF TESTS

- A. Engineer will, at his/her option, witness all tests.
- B. Testing Notification: At least 30 calendar days before each test, upon the approval of test procedure, notify Engineer in writing of the date, time, and location the test will be performed.
- C. Verify that test equipment bears a current calibration sticker before scheduling testing.
- D. If Engineer elects not to witness a test or tests, test reports shall nevertheless be submitted to Engineer for review and approval.
- E. Witnessing of test by Engineer shall not waive requirements in Specifications or relieve Contractor from its responsibility to produce test report in accordance with Specifications.

1.8 QUALITY ASSURANCE

- A. Comply with the requirements of the Project Quality Plan.
- B. Qualifications:
 - 1. Field testing of insulated power cables rated 2 kV and higher:
 - a. Shall be performed by a NETA certified technician working for an independent testing company under the direct supervision of Contractor.

- b. NETA technician shall have at least 5 years experience in construction acceptance testing.
 - c. Testing company shall be a NETA member and approved by Engineer.
 2. Field acceptance testing of each substation shall be performed under direct supervision of TES Substation Supervisor representing the manufacturer of the substation equipment, as specified in Section 34 21 05, Common Work Results for TES.
 3. Testing Company: Tests shall be performed by the manufacturer, or a company or agency employed by Contractor with all of the following qualifications:
 - a. Approved by Engineer: Once such a company or agency is approved they shall not be discharged or otherwise replaced by Contractor without written approval of Engineer.
 - b. Employees assigned to the project shall be personnel familiar with electrical testing procedures, electrical instrumentation, and general electrical networks.
 - c. Personnel must be capable of modifying the specified procedures to suit actual field conditions should such modifications become necessary.
 - C. Calibration of Testing Equipment:
 1. Testing equipment must be calibrated by an independent agency minimum every 12 months, or more frequently if recommended by the manufacturer.
 2. Calibration sticker shall be affixed to test equipment indicating last calibration date.
 - D. Quality of Test Data:
 1. Take a sufficient number of test readings to assure that random factors due to human error in reading the instruments and transient disturbances in electrical network have negligible influence on final results.
 2. Establish adequacy of the data as follows:
 - a. Examine data to verify that removal of either the highest or lowest value will not alter the arithmetic average of the group by more than 5 percent.
 - b. If the average would be altered by more than 5 percent, take one more set of data and combine results with the first set.
 - c. If the average of the combined data would still be altered by more than 5 percent if the highest or lowest value were removed, advise Engineer that an unstable condition might exist.

PART 2 - PRODUCTS

2.1 TESTING EQUIPMENT

- A. Electrical Megohmmeter for Insulation Testing:
 1. 1000 Vdc output voltage suitable for resistance measurement from 500 kilohm to 500,000 megohms. Use a megohmmeter with an internal bleeder resistor for discharge.

2. Approved Manufacturer: Hipotronics or approved equal.
- B. High-Potential Test Set:
1. Portable high-potential dc test set, 0 to 130 kVdc, 10 mA with regulated output.
 2. Internal shorting solenoid and discharge resistor.
 3. Full-scale accuracy: 2 percent.
 4. Capable of measuring cable insulation resistance up to 5,000,000 megohms.
 5. Approved Manufacturer: Hipotronics or approved equal.

2.2 FACTORY DESIGN TESTS

- A. General Requirements:
1. Tests shall be conducted by or under supervision of the equipment manufacturer.
 2. Demonstrate compliance with specified design requirements.
 3. Perform on production components, assemblies, subsystems and substations on the highest level of assembly that will allow demonstration of design compliance.
 4. Perform on the first production unit and perform in accordance with these Specifications.
- B. Perform Factory Design Tests as specified in each 34 21 xx and 34 22 xx section, under the Part 2 article titled "Source Quality Control."
- C. Existing Test Reports:
1. Unless otherwise specified, if design tests have already been performed by the manufacturer of equipment, existing test reports may be submitted to Engineer, who will determine whether the new design test may be waived.
 2. Existing test reports need not meet the format requirements specified in this Section, but content of reports shall include all relevant information.

2.3 FACTORY PRODUCTION TESTS

- A. General Requirements:
1. Tests shall be conducted by or under the supervision of the equipment manufacturer.
 2. Demonstrate that each unit to be delivered operates within specified limits and is in compliance with design requirements and industry standards.
 3. Test requirements may vary from an inspection and functional demonstration for a simple component to a full system functional demonstration of an assembly.
- B. Perform Factory Production Tests as specified in each 34 21 xx and 34 22 xx section, under the Part 2 article titled "Source Quality Control."
- C. Tests in this Section are in addition to those specified in other 34 21 xx and 34 22 xx sections.

- D. Electrically Insulated Floor and Wall Tests:
1. Perform hi-potential dielectric tests on the epoxy floor and wall insulation installed in each TES substation enclosure prior to the installation of substation equipment.
 2. Provide a hi-potential tester with a voltage range of 0-15,000 Vdc and a current range of 0-2000 microamperes dc to perform the tests.
 3. Floor: Perform a wet mop test as follows:
 - a. Provide a sponge mop with a non-metallic handle. Provide a copper plate behind the sponge with a wire terminal to attach the test lead.
 - b. Connect one lead from the tester to the copper disk and the other lead to the station ac ground bus.
 - c. Apply 2500 Vdc from the hi-potential tester, using precautions such as insulated boots and hot gloves to protect the test technician.
 - d. Saturate the mop with saline solution of 1/3 salt and 2/3 water (by volume).
 - e. Mop the entire insulated floor with the room darkened. Re-saturate the mop as necessary.
 - f. Visible arcing indicates inadequate dielectric strength of the epoxy coatings; apply additional layers of epoxy until the leakage current is lower than 50 microamperes.
 4. Walls: Perform a copper disk test as follows:
 - a. Provide a copper disc 4 inches in diameter and 1/4-inch thick. The disk shall have a non-conductive handle and wire terminal to attach the test lead.
 - b. Connect one lead from the tester to the copper disk and the other lead to the station ground bus.
 - c. Place the copper disc on the wall insulation at a minimum of 10 locations selected by Engineer where the laminate is fastened to the wall with mechanical fasteners.
 - d. Apply 2500 Vdc for 60 seconds and record the leakage current.
 - e. If leakage current is greater than 50 microamperes, epoxy insulation shall be applied to the fastener to increase the insulation and the fastener retested.

2.4 TES SUBSTATION FACTORY ACCEPTANCE TESTS

- A. General Requirements:
1. Perform test for each completely assembled substation at substation manufacturer's facility before shipping substation to site.
 2. Perform at ambient conditions unless a specific environmental or operating limit is necessary to demonstrate acceptable operation.
 3. Tests shall demonstrate that each substation is complete and ready for shipping to the site, both functionally and cosmetically.

- B. Pretest: Perform for each substation using an approved test procedure and submit a test report prior to performing the factory acceptance test for witnessing.
- C. Wire and Cable Testing:
1. Perform tests after factory wiring and terminations have been installed.
 2. Inspect wire and cable for physical damage and proper connections.
 3. Protect semiconductor devices against the test voltage by means of shorting jumpers or other methods accepted by Engineer, if they are not inherently protected by the circuit in which they are used.
 4. Continuity Tests: Check continuity from point to point and check for shorts to ground with an ohmmeter.
 5. Insulation Resistance Tests:
 - a. Measure insulation resistance with a 1000 Vdc megohmmeter.
 - b. Measure insulation resistance between conductor and ground.
 - c. Test cables after terminations are complete. Do not connect equipment to the cable system during tests.
 - d. Acceptance Criteria for 600 V wire and cable: 10 Megohms for 1,000 feet when measured at 25 C.
 - e. Test Failure: If insulation resistance values are unacceptable, correct deficiency and retest. If the test fails again, replace the entire wire or cable segment.
 6. High Potential Tests: In accordance with IEEE 400.
 - a. Passing Criteria: No insulation breakdown or excessive leakage current.
 - b. Failures: Locate and determine the trouble, replace defective wires, cables or components, make necessary corrections to installation, and retest without additional cost to the Owner.
 7. Control circuit wiring: Test for continuity and insulation after termination.
 8. Power and equipment branch circuits: Perform continuity test on conductors.
 9. Three-phase loads: Verify circuit phasing.
- D. Low-Voltage Panelboards and Enclosed Circuit Breakers:
1. Test circuits for connections in accordance with the wiring diagram.
 2. Test that insulation resistance to ground of nongrounded conductors is a minimum of 10 megohms.
 3. Test panelboard and load center enclosures for continuity to the grounding system.
 4. Test operation of circuits and controls. When testing, operate each control a minimum of 10 times and each circuit continuously for a minimum of 1/2 hour.
 5. Test that each panel has a balanced load.

-
- E. Ancillary Systems:
1. Perform operational and functional tests on auxiliary and ancillary systems including the following:
 - a. Auxiliary panelboards;
 - b. Auxiliary contacts;
 - c. Door interlocks;
 - d. Receptacles;
 - e. Interior, exterior, emergency, and cubicle lighting. Measure lighting levels and confirm that minimum lighting levels are met as required by Section 34 21 15, TES Lighting;
 - f. HVAC;
 - g. All systems provided in this Contract that are not specifically called out in this Section.
- F. General Substation Operation:
1. Perform a functional test of substation operation.
 2. Check the interlocks on the enclosure and panels for proper functioning alarm and operation of shutdown circuitry.
 3. Use strip chart recorders or oscillographs as required to provide a permanent record of the protective functions.
 4. Perform other tests as required by substation equipment manufacturer and Engineer to determine the acceptability of the installation and equipment.
- G. Medium-Voltage Ac Switchgear:
1. Perform on ac switchgear in accordance with IEEE C37.20.2:
 - a. Dielectric tests.
 - b. Mechanical operation tests.
 - c. Electrical operation and control wiring tests, except that the control wiring continuity shall be verified by actual electrical operation of control devices.
 - d. Grounding of instrument transformer cases.
- H. Ac Switchboard (VMF Only):
1. Verify that circuits are connected in accordance with the applicable wiring diagrams.
 2. Verify that circuits are continuous and free from short circuits.
 3. Verify that the insulation resistance to ground of non-grounded conductors is megger tested to not less than 10 megohms.

4. Verify that circuits are operable. Conduct tests to include operating each control not less than ten times and the continuous operation of each lighting and power circuit for not less than 1/2 hour.
- I. Dc Circuit Breaker: Perform on each dc circuit breaker after mounting in switchgear:
 1. Operation test.
 2. Position test: Disconnected, test, and connected positions.
 3. Alignment test of primary and secondary contacts.
 4. Interlocking test for all positions.
 - J. Dc Switchgear: Perform Production Tests as specified in IEEE C37.20.1:
 1. Dielectric tests.
 2. Mechanical operation tests.
 3. Grounding of instrument transformer case test.
 4. Electrical operation and control wiring tests: Verify by actual electrical operation of the component control devices.
 - K. Positive and Negative Disconnect Switches: Perform Production Tests as specified in IEEE C37.41.
 1. Perform standard production tests on all switches to check the quality and uniformity of workmanship and materials used, including the following:
 2. Check for gaps, using a feeler gage (or other approved method) at each contact and assembly point. Gaps are grounds for rejection.
 3. Test operation of all components.
 4. Perform power frequency dielectric withstand test.
 5. Test electric resistance of current path.
 - L. Dc Relays:
 1. Verify proper operation and setting of all relays including rate of rise, frame fault relay and rail-to-earth relay.
 2. Where applicable, settings to be in accordance with approved relay coordination curves.
 - M. Rectifier Transformer:
 1. Perform insulation tests between windings and between windings to ground and between the core to ground using a 2500 Vdc megohmmeter for 1 minute.
 2. Perform functional tests of temperature protective devices.
 - N. Rectifiers:
 1. Perform insulation tests between the diode strings and rectifier enclosure using a 2500 Vdc megohmmeter for one minute.

2. Perform insulation tests between the enclosure and ground using a 2500 Vdc ohmmeter for 1 minute.
 3. Perform a functional test of all temperature, protective, monitoring and alarm devices.
- O. Emergency trip stations (ETS): Perform functional test.
- P. Substation Automation System (SAS):
1. Simulate alarm and analog functions at each device on Alarm Points List in Section 34 21 31, TES Substation Automation System (SAS).
 - a. Simulation shall replicate actual field activation of functions to the extent possible.
 - b. Include method of simulation of functions in test procedure for approval by the Engineer.
 2. Demonstrate downloading of event log to flash drive or laptop.
- Q. SCADA: Simulate alarm functions at each device on Alarm Points List in Section 34 21 31, TES Substation Automation System (SAS).
- R. Transfer Trip: Simulate transfer trip and verify correct outputs at PLC for transfer trip.
- S. Frame Fault (Device 64HS & GS) Tests:
1. Connection: As shown in the one-line diagram.
 2. Test: Simulate a 750 Vdc to frame fault by passing low dc current levels through the relays.
 3. Criteria: Maximum total clearing time including operation of the 64HS & GS relay, the substation lock-out relay, and the tripping of the main ac and dc feeder breakers shall not exceed 300 ms.
 4. At the time of testing, provide graphical outputs, including time characteristics, onsite for review and approval.
- T. Rail Voltage Monitoring and Grounding Devices Tests:
1. Test: Demonstrate proper function of the rail-to-earth relay and rail-to-earth grounding device.
 - a. Simulate rail-to-earth voltages and currents.
 - b. Show that the substation will alarm, trip, and short circuit rail to earth when the voltage and currents exceed the alarm, trip, and short circuit points specified in Section 34 21 33, TES Rail Voltage Monitoring and Grounding System.

PART 3 - EXECUTION

3.1 TES SUBSTATION GROUND GRID TESTS

- A. Pretest the substation ground grid before pouring slab to verify that the required maximum resistance can be achieved, in accordance with Section 34 22 26, TES Grounding and Bonding.

- B. Retest the ground at each substation before conducting Field Acceptance Tests.
- C. Perform testing using the fall of potential method in accordance with IEEE Standard 81.
- D. If a graph of readings does not show the characteristic shape, move current probe further out and repeat procedure.
- E. For each test, submit full fall of potential graph showing each reading.
- F. Passing ground resistance test: 5 ohms or less.

3.2 TES FIELD ACCEPTANCE TESTS

- A. General Requirements:
 - 1. Perform tests in accordance with NETA Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
 - 2. Perform after complete installation of each TES substation.
 - 3. No equipment shall be energized or placed in operating mode until completion of Field Acceptance Testing and permission of Engineer.
 - 4. Tests shall demonstrate that each substation, cable installation, or other equipment is ready for energization and revenue service, both functionally and cosmetically.
- B. Prior to Witnessed Testing:
 - 1. Verify that all equipment is properly installed in accordance with approved drawings and in operable condition.
 - 2. Verify that all open inspection items and NCRs have been corrected.
 - 3. Pretest TES substation to ensure that all necessary troubleshooting has been completed prior to witness testing.

3.3 TES SUBSTATION FIELD ACCEPTANCE TESTS

- A. Wire and Cable Testing:
 - 1. Retest wire and cable after delivery of substation in accordance with Paragraph above titled Factory Acceptance Test.
- B. Electrically Insulated Floor and Wall Tests:
 - 1. Repeat factory tests on wall and floor areas not covered by installed switchgear.
 - 2. Verify that insulated floor and walls have not been damaged in shipping.
- C. General Substation Operation:
 - 1. Perform a functional test of substation operation before energizing the substation. Energize only circuits 600V or less for functional test.
 - 2. Include steps specified above in Part 2 under Paragraph titled "Factory Acceptance Test" and Sub-paragraph titled "General Substation Operation."

- D. Dc Switchgear:
1. High-potential tests:
 - a. Disconnect high-resistance ground relay, Device 64, for this test.
 - b. Perform test between the ac and dc switchgear, including fasteners and the isolation laminate, at 2500V dc. Leakage current shall be less than 50 microamperes.
 - c. Perform test from dc switchgear enclosure to ground at 2500 Vdc. Leakage current shall be less than 50 microamperes.
 - d. Perform continuity tests on all interconnecting cables and buses.
 - e. Perform insulation test on all interconnecting feeder cables using a 2500 Vdc megohmmeter for 1 minute.
 - f. Test positive and negative feeder buses to ground using a 2500 Vdc megohmmeter for 1 minute.
 - g. Verify load measuring and reclosing functions.
 2. Verify proper operation of all interlocks and Kirk key schemes.
- E. Dc Relays:
1. Verify proper operation and setting of all relays including rate of rise, frame fault relay and rail to earth relay.
 2. Where applicable, settings to be in accordance with approved relay coordination curves.
- F. Rectifier Transformer:
1. Perform insulation tests between windings and between windings to ground and between the core to ground using a 2500 Vdc megohmmeter for 1 minute.
 - a. Pass/fail criteria: Test is passed if megohmmeter is able to hold the specified voltage for 1 minute.
 2. Perform functional tests of temperature protective devices.
- G. Rectifiers:
1. Perform insulation tests between the diode strings and rectifier enclosure using a 2500 Vdc megohmmeter for one minute.
 - a. Pass/fail criteria: Test is passed if megohmmeter is able to hold the specified voltage for 1 minute.
 2. Perform insulation tests between the enclosure and ground using a 2500 Vdc ohmmeter for 1 minute.
 - a. Pass/fail criteria: Test is passed if megohmmeter is able to hold the specified voltage for 1 minute.
 3. Perform a functional test of all temperature, protective, monitoring and alarm devices.

-
- H. Emergency trip stations (ETS): Perform functional test.
- I. Substation Automation System:
1. Repeat tests specified above in Part 2 under Paragraph titled "Factory Acceptance Test."
 2. Demonstrate with actual field activation of functions to the extent possible.
- J. SCADA: Repeat tests specified above in Part 2 under Paragraph titled "Factory Acceptance Test."
- K. Transfer Trip: Perform complete functional test of transfer trip, verifying transfer tripping at adjacent substations in accordance with the requirements in Section 34 21 19, TES Dc Switchgear.
- L. Frame Fault (Device 64HS & GS) Tests:
1. Connection: As shown in the one-line diagram.
 2. Test: Simulate a 750 Vdc to frame fault by passing low dc current levels through the relays.
 3. Criteria: Maximum total clearing time including operation of the 64HS & GS relay, the substation lock-out relay, and the tripping of the main ac and dc feeder breakers shall not exceed 300 ms.
 4. At the time of testing, provide graphical outputs, including time characteristics, onsite for review and approval.
 5. In the event that certain test conditions do not conform to the test procedure, make necessary field adjustments, perform necessary calculations to demonstrate successful test completion, present the calculation method to Engineer for review, and include with the test report.
- M. Rail Voltage Monitoring and Grounding Devices Tests:
1. Test: Demonstrate proper function of the rail-to-earth relay and rail-to-earth grounding device.
 - a. Simulate rail-to-earth voltages and currents.
 - b. Show that the substation will alarm, trip, and short circuit rail to earth when the voltage and currents exceed the alarm, trip, and short circuit points specified in Section 34 21 33, TES Rail Voltage Monitoring and Grounding System.
- N. Battery:
1. Perform after substation equipment has been installed onsite.
 2. Acceptance tests: Perform in accordance with IEEE 1188.
 3. Terminal connection resistance: Test with a micro ohmmeter. Values shall not exceed those specified in IEEE 1187.
 4. Capacity test: Perform in accordance with IEEE 1188.

5. Perform load test demonstrating that batteries comply with the requirements in Section 34 21 25, TES Dc Control Power, by duplicating the conditions stated under Battery Duty Cycle section.
- O. Battery Charger:
1. Perform after substation equipment has been installed onsite.
 2. Perform acceptance tests in accordance with NEMA PE 5.
- P. Ancillary Systems:
1. Repeat tests specified in Part 2, above under the Paragraph titled "TES Substation Factory Acceptance Test."
- Q. Power Meter:
1. Testing shall be performed by a qualified testing agency using calibrated reference standard devices.
 - a. The test instruments shall be calibrated and traceable to the National Institute of Standards and Technology (NIST).
 - b. Calibrate analog instruments no more than 6 months prior to testing.
 - c. Calibrate digital instruments no more than 12 months prior to the test.
 - d. Provide certificates of calibration for the reference standard devices.
 2. Test for accuracy of the following:
 - a. Four-quadrant energy measurement accuracy: kWh imported, kWh exported, kWh net, kVARh imported, kVARh exported, kVARh net, kVAh imported, kVAh exported, kVAh net.
 - b. Power measurement accuracy including active, reactive and apparent (kW, kVAR and kVA).
 - c. Demand Accuracy.
 - d. L-L and L-N voltage measurement accuracy of every phase.
 - e. Current measurement accuracy of every phase.
 - f. Power Factor.
 - g. Frequency.
 - h. CT accuracy test (10 percent, 20 percent, 30 percent, 40 percent, 50 percent through rated current, including ratio test), CT phase error test, PT accuracy test (including ratio test), burden test of CT circuit.
 3. Verify metering transformer configuration and wiring match the power meter configuration, CT/PT polarities are correct and CT/PT ratios are correct.

3.4 DC FEEDER CABLE FIELD TESTING AND INSPECTION

- A. Before connecting cables to rails or OCS, perform dc insulation-resistance test in accordance with NETA ATS Section 7.3.3, Cables, Medium- and High-Voltage, using a dc high-potential test set.

- B. Perform visual and mechanical inspection of cable in accordance with NETA ATS Section 7.3.3.

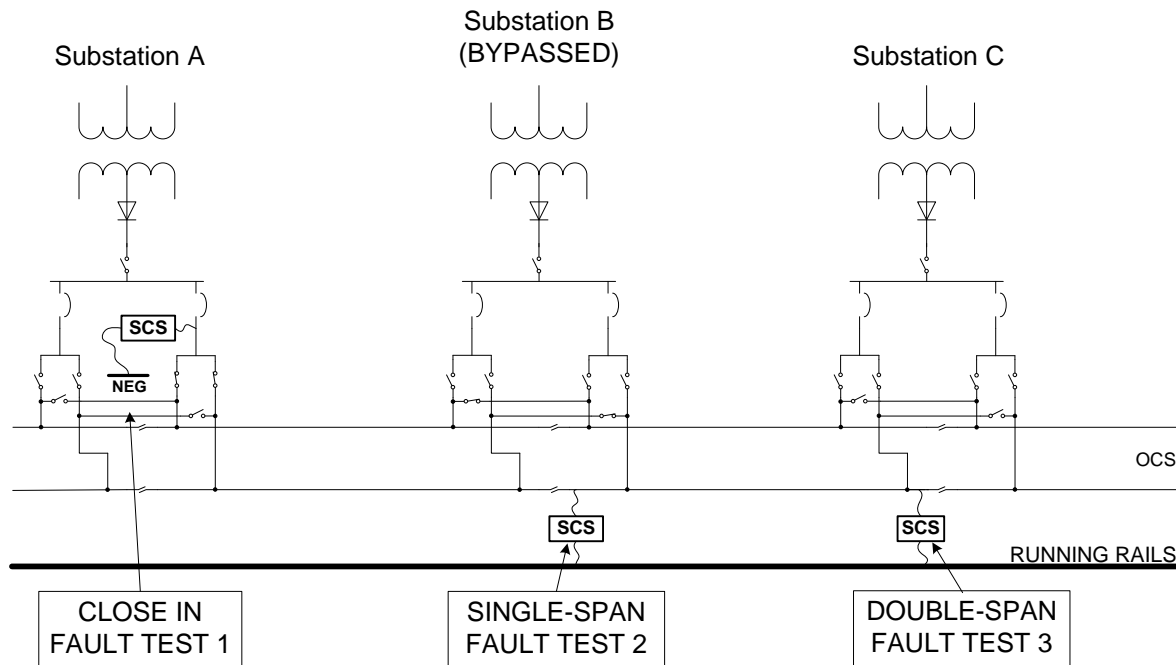
3.5 TES SUBSTATION ENERGIZATION

- A. Obtain permission from Engineer before energizing substation.
- B. Rectifier Transformers: Adjust transformer taps for optimum dc output voltage based on ac service voltage at each location.

3.6 INTEGRATED TES TESTING

- A. General Requirements:
 - 1. Perform in cooperation with other disciplines to demonstrate the proper function of the TES.
 - 2. Tests shall demonstrate that all interfaces are correct and operable.
 - 3. Provide test procedure and test report unless stated otherwise.
- B. Short Circuit Test:
 - 1. Location: Perform the test using the area encompassed by three consecutive substations, as selected by the Engineer (see Figure 1, below).
 - 2. Disconnect Switch Configuration: Perform this test with dc disconnect switches at the center substation (Substation B) in bypass mode, to effectively remove from the circuit the OCS section insulators associated with that substation.
 - 3. Disable the automatic tripping elements of the dc breakers during testing in order to obtain data of actual fault current levels.
 - 4. Energize only Substation A for each test. The substations on both sides of Substation A and Substation C must all be de-energized.

Figure 1 - Diagram for Close-in, Single-Span and Double-Span Fault Tests



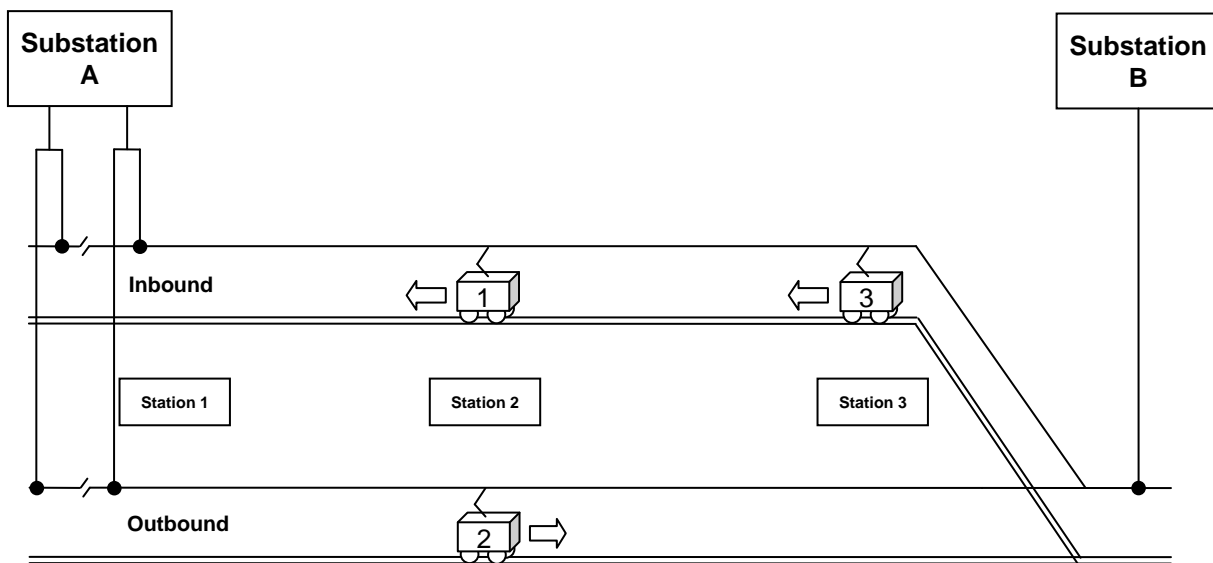
5. Close-in Fault Test 1:
 - a. Purpose: To determine system I_{max} and adjust protection relay settings.
 - b. Preparation: Place a jumper across line and load terminals of the feeder breaker and move to the connected position.
 - c. Test: Using a short circuit switch (SCS) apply a bolted fault from line side of the dc feeder breaker to the negative bus.
 - d. After Test: Verify that the dc breaker trips according to protection coordination study.

6. Single-Span Fault Test 2:
 - a. Purpose: To capture the upper limit of the di/dt range on dc protective relays.
 - b. Test: Using a short circuit switch (SCS) apply a bolted fault from messenger wire to rail at Substation B.
 - c. After Test: Verify and apply new protective settings if necessary.
 - d. Re-test: Repeat Single-Span Fault Test with new settings to verify that the breaker trips according to new protection setting.

-
7. Double-Span Fault Test 3:
 - a. Purpose: To capture the lower limit of the di/dt range on dc protective relays.
 - b. Test: Using a short circuit switch (SCS) apply a bolted fault from messenger to rail at the location furthest from the feed point of the substation under test.
 - c. After Test: Verify that the dc breaker trips according to protection coordination study.
 - C. Rail Voltage Monitoring and Grounding Devices Tests:
 1. Initial Chart Recording:
 - a. For each substation, provide a 48-hour chart recording of the rail-to-earth voltages and currents measured at the terminals of the negative cubicle during simulated revenue service.
 - b. Set horizontal and vertical scale such that both time duration and magnitude of rail-to-earth voltages are clearly readable.
 - c. Resolution shall be no less than 100 ms for time and 2 V for voltage
 2. Adjustment: Iteratively adjust the annunciation and trip setpoints until optimum settings have been determined to the satisfaction of Engineer. This process may require several weeks or more of monitoring and adjusting settings. Submit settings to Engineer after the following conditions are met:
 - a. The substation remains on line for 14 days without a nuisance trip (tripping under normal operation without apparent reason) including times when adjacent substations are removed from service for at least 1 hour.
 - b. The recommended settings conform to IEEE 80 for safe touch and step potential.
 3. Final Record Chart Recording:
 - a. For each substation, after the rail voltage monitoring and grounding devices have been set and the settings accepted by Engineer, provide a 48-hour chart recording of rail-to-earth voltages and currents measured at terminals of dc switchgear.
 - b. Set horizontal scale so that both time duration and magnitude of rail-to-earth voltages are clearly readable.
 - c. Make recording on a weekday, during actual or simulated revenue service and make a part of the as-built record documentation.
 - D. Train Start Test:
 1. Engineer will provide the test procedure and will conduct the test. Provide support as requested by the Engineer and submit test report.
 2. Location: Test will be performed using the area encompassed by two consecutive substations, as selected by the Engineer (see Figure 2, below).

- 3. Purpose:
 - a. Verify that TES substations will allow multiple trains to start under full load.
 - b. Adjust protection relay settings.
- 4. Testing Instruments: Provide two chart recorders to monitor di/dt.
- 5. Personnel: Provide a technician for two days.
- 6. Test Support: Connect chart recorders in the two substations under test. Adjust protection relay settings if necessary, as determined by test results.

Figure 2 - Diagram for Train Start Test



- E. VMF APS and ETS Test:
 - 1. Test APS with the streetcar vehicle. Verify the operation as described in Section 34 21 70, VMF TES Control and APS.
 - 2. Test must include verification and proper operation of the following equipment:
 - a. APS control cabinet.
 - b. APS disconnect switch.
 - c. VMF Ac MCC.
 - d. VMF ETS pushbuttons.
 - e. Shop TPSS S1 ac and dc switchgear.

PART 4 - MEASUREMENT AND PAYMENT**4.1 MEASUREMENT**

A. The quantities of accepted work will be measured in the following units. All measurements will be plan measure except for authorized changes.

1. Description: Lump Sum

4.2 PAYMENT

A. Payment will be made at the respective unit or lump-sum price listed in the proposal and shall be full compensation for all labor, materials, and equipment necessary to complete the respective unit in place. There will be no separate measurement or payment for any item of work not specifically identified and listed in the proposal, and all such work shall be considered a subsidiary item with all costs pertaining thereto included in the prices for other items listed in the proposal. At the Engineer's option, partial payment may be made for any lump sum item listed in the proposal, providing that the Contractor is diligently and satisfactorily pursuing full completion of such partially complete item in accordance with the approved job progress schedule.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 34 21 95**TES OPERATION AND MAINTENANCE DATA****PART 1 - GENERAL****1.1 SUMMARY**

- A. This Section includes Operation and Maintenance (O&M) Manual for TES Work.

1.2 RELATED SECTIONS

- A. SECTION 34 21 96 – TES Project Record Documents
B. SECTION 34 21 97 – TES Demonstration and Training

1.3 SUBMITTALS

- A. Procedures: Section 01 33 00, Submittal Procedures.
- B. Quality Assurance:
1. Submit names, qualifications, and a sample of similar work for each person who will be involved in producing the O&M Manual, within 90 days after NTP.
 2. Submit O&M Manual outline minimum 30 days before starting work on O&M Manual.
 3. Submit specified Quality Control checklist at the same time as the O&M Manual signed by the quality checker.
- C. O&M Manual:
1. Submit minimum of 120 days before scheduled energization of first substation. Ensure that O&M Manual is approved prior to starting training of Owner's maintenance and operations personnel as required by Section 34 21 97, TES Demonstration and Training.
 2. Submit an electronic version in PDF format for review.
 - a. Include a page and PDF bookmark for each tab that will be inserted in the hard copy final version.
 - b. If the initial submittal does not include the required Quality Control Checklist and the specified O&M Manual formatting, organization, and content it will not be reviewed in detail.
 3. After final approval of submitted O&M Manual submit 10 hard copy sets and 5 electronic copies on CD.
- D. Renewal Parts Catalog:
1. Submit sample within 90 days of NTP.
 2. Submit minimum of 90 days before scheduled energization of first substation.
 3. Submit an electronic version in pdf format for review.

4. After final approval of submitted Renewal Parts Catalog submit 10 hard copy sets and 5 electronic copies on CD.

1.4 QUALITY ASSURANCE

- A. Comply with the requirements of the Project Quality Plan.
- B. Qualifications:
 1. The O&M Manual must be laid out and assembled by a person with the following competence:
 - a. Skilled in organization with experience producing manuals or other large documents of this kind.
 - b. Competent at using the word processing program used, including the ability to create a template for headings to be used throughout the document and produce an automatic table of contents.
 - c. Competent at using Adobe Acrobat and producing hierarchical bookmarks
 2. Each written portion of the O&M Manual must be produced or edited by a person or persons with the following competence:
 - a. Skilled in writing in English with proper paragraph construction, sentence construction, grammar, spelling, and punctuation.
 - b. An ability to write clearly and concisely.
 - c. An ability to organize the written material in such a way that it is easy to navigate.
 - d. Familiar with operation, troubleshooting, and maintenance of the equipment included in the manual.
 3. Submit the names and qualifications of the persons who will be involved in production of the manual, describe the role of each person, and provide a sample of comparable work produced by each person.
- C. Quality Control:
 1. Prepare an O&M Manual outline including headings and two levels of subheadings for submittal. Verify that the approved outline is used to assemble the O&M Manual.
 2. Prepare an O&M Manual Quality Checklist including the following and verify that each item has been included before submittal:
 - a. Each requirement listed in the paragraph below titled "Format."
 - b. Each piece of equipment that will be included in the O&M Manual.
 - c. Each type of content required by the Specifications.

PART 2 - PRODUCTS**2.1 OPERATION AND MAINTENANCE MANUAL****A. Format:**

1. If the Manual has multiple volumes, include the following in each volume, specific to that volume of the manual:
 - a. Frontispiece: Preceding and facing the title page, showing a recognizable illustration of the equipment described.
 - b. Title Page: Include the name and function of the equipment, manufacturer's identification number(s), and the Contract Specifications number(s) and title(s).
 - c. Table of Contents: List the sections and subsection titles with the page on which each starts and a list of included drawings for each section or subsection.
2. Consecutively number each page, restarting the numbering for each volume, with the volume number included in the page number. For example, Page 2-36 would be the page number of the 36th page in Volume 2.
3. Present content in a logical hierarchy with headings and subheadings in a consistent format that make it easy to navigate the manual.
4. PDF Format:
 - a. Create a hierarchy of bookmarks, with each major section as a top-level bookmark, and subsections as bookmark subheadings.
 - b. The bookmarks must match the structure of the table of contents and include the headings and subheadings in the same hierarchical structure.
5. Hard Copy Format:
 - a. Dividers: Insert dividers with identifying tabs to separate sections of the manual.
 - b. Pages: 8-1/2 inches by 11 inches in size or folded to that size.
 - c. Binders: Heavy duty, D-ring, locking, three-ring binders not filled to more than 2/3 of their capacity.
 - d. Paper: 47 pound bond.

B. General Requirements for Content:

1. Information shall cover the exact equipment provided and shall not consist of marked up general catalog data.
2. Delete information on material or equipment not used.
3. Include drawings and diagrams for major assemblies and subassemblies.

4. Include descriptive brochures providing physical and functional description of the equipment.
 - a. Brochures shall be original, printed materials or high quality color prints from electronic media.
 - b. Brochures shall not be photocopies.
 5. Do not include as-built drawings in the O&M Manual. Submit separately in accordance with Section 34 21 96, TES Project Record Documents.
- C. Organization of Content:
1. Provide major headings and subheadings corresponding to major topics and subtopics that present the information in a logical, easy to access format.
 2. Include only major headings and subheadings in the Table of Contents.
 3. Provide a tab for each major heading and subheading.
 4. Within the manual, at the beginning of each subtopic include a detailed list of the individual items included in that subtopic, with page numbers.
 5. Manufacturer's publications must be organized in one of two ways:
 - a. Placed in the same section as Contractor-written content by system, such as "Dc switchgear," or
 - b. Separate from Contractor-written content, but organized by system using the same structure used to organize the Contractor-written content. Contractor written content must include references to manufacturer's publications including the following:
 - 1) Subsection name and number.
 - 2) O&M Manual sequential page number.
 - 3) Manufacturer name and model number.
 - 4) Title of publication.
 6. Titles of headings and subheadings must be generic, such as "HVAC System," not names of manufacturers or part numbers.
- D. Content: Provide maintenance and operating instructions for all equipment and systems installed, including the following:
1. Installation:
 - a. Pre-installation inspection.
 - b. Installation verification checklist.
 - c. Torque: Include manufacturer's recommended torque information for each type of bolted connection used.
 - d. Calibration.
 - e. Preparation for operation for initial installation.

2. Operation:
 - a. Performance specifications.
 - b. Operating limitations.
 - c. Include step-by-step procedures for
 - 1) Starting: Provide start-up checklist.
 - 2) Restarting.
 - 3) Operating.
 - 4) Shutdown.
 - 5) Emergency requirements.
3. Preventative Maintenance:
 - a. Include step-by-step procedures for
 - 1) Inspection.
 - 2) Operation checks.
 - 3) Cleaning.
 - 4) Lubrication.
 - 5) Adjustments.
 - b. Indicate required tools
 - c. Indicate annual maintenance schedule
4. Corrective Maintenance:
 - a. Include step-by-step procedures for
 - 1) Repair.
 - 2) Disassembly.
 - 3) Reassembly of the equipment for proper operation.
 - b. Indicate required tools
5. Overhaul:
 - a. Parameters that indicate an overhaul is required.
 - b. Disassembly.
 - c. Parts to replace.
 - d. Adjustment, cleaning, etc. for parts not replaced.
 - e. Reassembly of the equipment for proper operation.
 - f. Preparation for operation after overhaul.

- E. Appendices: Include the following in a separate volume, each in its own tabbed appendix. Do not include this information in the body of the manual:
1. Glossary, abbreviations, symbols.
 2. Bill of Materials:
 - a. Organize by system and subsystem.
 - b. Provide complete with all necessary information, including part numbers and catalog item numbers if applicable, for identifying parts.
 - c. Identify parts or assemblies obtained from another manufacturer by the name of that manufacturer and the manufacturer's identifying part number.
 - d. Supply the size, capacity, or other characteristics of the part if required for identification.
 3. Torque table for all types of bolts used in bolted connections.
 4. Spare Parts and Special Tools:
 - a. Provide a list of contractual and recommended spare parts
 - b. Provide a list of special tools required for maintenance.
 5. Safety: Safety precautions.
 6. Testing: Copies of Field Acceptance Testing procedures.
 7. Warranty information.
 8. Other appendices as needed.

2.2 RENEWAL PARTS CATALOG

- A. Organize by system and subsystem.
- B. Enumerate and describe every component with its related parts, including supplier's number, Contractor's number, Drawings Apparatus Reference number, and provision for entry of the Owner's part number.
- C. Use cut-away and exploded drawings to aid identification of parts not readily identified by description.
- D. Parts common to different components, such as bolts and nuts, shall bear the same Contractor's number with a reference to other components in which they are found.
- E. For each part or component, list all the assemblies of which it is a component.
- F. Standard parts:
 1. Identify commercially available items such as common standard fastenings, fuses, lamps, galvanized pipe, nuts and bolts, etc., by standard hardware nomenclature besides Contractor's number.
 2. Furnish a separate list of these items in the catalog with adequate information to order these items through commercial channels.

- G. Furnish a complete itemization of servicing materials (oils, paints, special compounds, greases, etc.) required and component requiring its use.
- H. Furnish ordering and procurement information required for components and subassemblies to the lowest level replaceable component. Ensure that the Owner will not need to request information from Contractor at a future date.
- I. Submit lists in the form of reproducible Bills of Materials suitable for loose-leaf binding adequately cross-referenced to related drawings and Bills of Material.

PART 3 - EXECUTION

3.1 REVISIONS

- A. If subsequent modifications to the equipment require revised operation and maintenance procedures:
 - 1. Revise the O&M Manuals to show the equipment as installed.
 - 2. Revise by issue of replacement pages to the final O&M Manuals, or by reissue of the O&M Manuals, at the Engineer's option.
 - 3. Submit the revisions to the O&M Manuals not later than 30 Days following revision of the equipment.

3.2 SPECIAL SUBMITTAL PROCEDURES

- A. Work with Engineer to review O&M Manuals together in a meeting environment, if requested
- B. Revise manuals in accordance with directions and comments from both meeting inputs and formal mark-ups (by reviewers)
- C. Resubmit as required in accordance with Section 01 33 00, Submittal Procedures.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

- A. The quantities of accepted work will be measured in the following units. All measurements will be plan measure except for authorized changes.
 - 1. Description: Lump Sum

4.2 PAYMENT

- A. Payment will be made at the respective unit or lump-sum price listed in the proposal and shall be full compensation for all labor, materials, and equipment necessary to complete the respective unit in place. There will be no separate measurement or payment for any item of work not specifically identified and listed in the proposal, and all such work shall be considered a subsidiary item with all costs pertaining thereto included in the prices for other items listed in the proposal. At the Engineer's option, partial payment may be made for any lump sum item listed in the proposal, providing that the Contractor is diligently and satisfactorily pursuing full completion of such partially complete item in accordance with the approved job progress schedule.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 34 21 96**TES PROJECT RECORD DOCUMENTS****PART 1 - GENERAL****1.1 SUMMARY**

- A. This Section includes requirements for TES as-built drawings.

1.2 SUBMITTALS

- A. Procedures: Section 01 33 00, Submittal Procedures.
- B. Incremental Submission of As-Built Drawings
1. Upon request from the Engineer, make available copies of selected as-built drawings in color.
 2. Incremental as-built drawings requested by the Engineer shall be stamped "As-Built", signed, and dated by Contractor.
- C. Final Submission of As-Built Drawings:
1. At completion of Work, and before requesting Final Acceptance of Work, deliver Final as-built drawings to the Engineer.
 2. Stamp drawings "As-Built Record."
 3. Submit five hard copies and three electronic copies on CD or DVD in AutoCAD (latest version) and in PDF formats.
 4. Submit as-built drawings and include the following information:
 - a. Date of submission.
 - b. Project title and number.
 - c. Contractor's name and address.
 - d. Certification that as-built drawings as submitted are complete and accurate.
 - e. Signature of Contractor or its authorized representative.

PART 2 - PRODUCTS

Not Used.

PART 3 - EXECUTION**3.1 MAINTENANCE OF AS-BUILT DRAWINGS**

- A. During factory wiring and testing of a TPSS, or other equipment, immediately update drawings or documents affected by a change in the circuits or equipment.

- B. During on-site installation and testing, maintain in each TPSS plan books of approved shop drawings, and immediately update drawings affected by a change in the circuits or equipment.
- C. Protect drawings from damage.
- D. Update as-built documents continuously during the course of construction.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

- A. The quantities of accepted work will be measured in the following units. All measurements will be plan measure except for authorized changes.
 - 1. Description: Lump Sum

4.2 PAYMENT

- A. Payment will be made at the respective unit or lump-sum price listed in the proposal and shall be full compensation for all labor, materials, and equipment necessary to complete the respective unit in place. There will be no separate measurement or payment for any item of work not specifically identified and listed in the proposal, and all such work shall be considered a subsidiary item with all costs pertaining thereto included in the prices for other items listed in the proposal. At the Engineer's option, partial payment may be made for any lump sum item listed in the proposal, providing that the Contractor is diligently and satisfactorily pursuing full completion of such partially complete item in accordance with the approved job progress schedule.

END OF SECTION

SECTION 34 21 97**TES DEMONSTRATION AND TRAINING****PART 1 - GENERAL****1.1 SUMMARY**

- A. This Section includes the following:
 - 1. Requirements for instruction and training of Operations and Maintenance personnel in the management, operation, and maintenance of provided equipment and systems.
 - 2. Requirements for training materials.

1.2 SUBMITTALS

- A. Procedures: Section 01 33 00, Submittal Procedures.
- B. Submit the names and qualifications of the persons who will be involved in production of the manuals, describe the role of each person, and provide a sample of comparable work produced by each person.
- C. Submit resumes of proposed instructors.
- D. Submit an electronic version of the Instructor Guide three months before the start of training in PDF format for review.
- E. Submit an electronic version of the Training Manual 90 days before the start of training in PDF format for review.
- F. After final approval of submitted Instructor Guide submit 3 hard copies.
- G. After final approval of submitted Training Manual submit 10 hard copies.
- H. Training shall not commence until the Training Program Plan and Instructor Guides are approved by the Engineer.
- I. Submit videos before the start of training if videos are used in training. Submit on DVD in MPEG-4 format.
- J. Submit Training Reports not later than 1 week after completion of course.

1.3 QUALITY ASSURANCE

- A. Comply with the requirements of the Project Quality Plan.
- B. Qualifications:
 - 1. The Instructor Guide and Training Manual must The O&M Manual must be laid out and assembled by a person with the following competence:
 - a. Skilled in organization with experience producing manuals of this kind.

- b. Competent at using the word processing program used, including the ability to create a template for headings to be used throughout the document and produce an automatic table of contents.
- c. Competent at using Adobe Acrobat and producing hierarchical bookmarks
2. Each written portion of the Instructor Guide and Training Manual must be produced or edited by a person or persons with the following competence:
 - a. Skilled in writing in English with proper paragraph construction, sentence construction, grammar, spelling, and punctuation.
 - b. An ability to write clearly and concisely.
 - c. An ability to organize a training program in a logical way so that each lesson builds on the previous lessons and trainees are able to achieve the specified goals.
 - d. Familiar with operation, troubleshooting, and maintenance of the equipment included in the manual.
3. Submit the names and qualifications of the persons who will be involved in production of these manuals, describe the role of each person, and provide a sample of comparable work produced by each person.
4. Qualifications of Instructors:
 - a. Must be fluent in English.
 - b. Must be experienced in the system for which they are conducting training.
 - c. Must have minimum two years experience conducting training.

PART 2 - PRODUCTS

2.1 TRAINING PROGRAM

- A. Design program to train the Owner's maintenance and operations personnel in details of furnished equipment and systems and enable them to operate, service, and maintain systems such that systems will perform and continue to perform in accordance with requirements of this Contract.
- B. Provide a logically related sequence of separate training sessions covering System Operation, Overall System Maintenance, and Equipment Operation and Maintenance.
- C. Ensure operations and maintenance personnel are fully trained prior to start of passenger service.
- D. Operations and Maintenance Personnel Qualifications:
 1. Assume personnel to be trained have only basic skills pertinent to their craft.
 2. Assume Operations and Maintenance personnel to be trained have no knowledge of features of specific equipment or systems to be taught.

2.2 TRAINING COURSE

- A. Course requirements:
1. Include classroom, hands-on, and/or field instruction, as appropriate, and models, mockups, documentation, and aids to carry out the program.
 2. Class Sizes: Unless otherwise specified elsewhere in these Specifications, the Owner will be able to send up to 10 participants to the training course specified.
 3. Duration: Maximum 8 hours per day.
 4. Training Location and Classrooms: Conduct training sessions in facilities provided by the Owner. The facilities will be equipped with tables, chairs, and one cabinet with lock hasp.
 5. Provide video players and projectors as required.
 6. Provide literature and equipment necessary to train personnel.
 7. Training on actual system equipment and spare equipment will be permitted; however, such use shall not interfere with pre-revenue tests and system demonstrations.
- B. Equipment Operations and Maintenance Training:
1. Provide training in the operation and maintenance of equipment systems provided.
 2. Provide hardware training including, but not limited to:
 - a. Equipment operation.
 - b. Troubleshooting procedures, including field diagnostics and test equipment.
 - c. Interface with other equipment.
 - d. Preventative maintenance procedures.
 3. Provide Operations and Maintenance personnel with a thorough knowledge of the equipment and its operation, its interface with other equipment, and the capabilities and use of test equipment.
 4. Provide participants with theoretical background and hands-on experience in troubleshooting, repair procedures, and preventive maintenance procedures.
 5. Enable Operations and Maintenance personnel to develop a self sufficient hardware maintenance team for the equipment.
 6. Include a page by page review and explanation of approved O&M Manuals.
- C. Supplemental Training:
1. Provide extended, duplicate, or additional training for the systems provided, as deemed necessary by the Engineer, due to modification of systems and equipment configuration made after completion of the scheduled training course.

- D. Training Materials:
1. Use approved O&M Manuals and as-built drawings as part of training materials, but do not duplicate this information or incorporate it into the training materials specified in this Section.
 2. Provide each course participant with a copy of the Training Manual and other pertinent material, including O&M Manual and As-Built Drawings, prior to commencement of course.
 3. Upon completion of the course, instructor's manuals, training manuals, and training aids become the property of the Owner unless such items are specifically exempted by the Engineer.
 4. The Owner reserves the right to copy training materials and aids for use in Owner-conducted training courses.
 5. Provide special tools, equipment, training aids, and other materials required to train course participants. Provide sufficient quantity of special tools and other training equipment for the number of participants attending the course.
 6. Use actual hardware and photographs taken during the manufacturing process wherever possible. Actual hardware used for training must pass re-inspection and acceptance testing prior to being placed in service.
 7. Videos:
 - a. Do not use videos as a replacement for a classroom instructor, or as the primary training vehicle.
 - b. Use prerecorded lectures only as supplementary training material.
 - c. The Owner shall have the right to take video recordings of training courses presented by the Contractor. The Owner shall also have the right to use these videos to train personnel in the future.

2.3 INSTRUCTOR GUIDE

- A. Provide Owner-specific materials prepared specifically for training Owner's personnel.
- B. The Instructor Guide may not be combined with the Training Manual, and must include the following:
1. A one-page training program summary including a list of each training session with a brief description and the estimated time required for the session.
 2. A table of contents.
 3. An introduction explaining the overall format for training.
 4. A separate section for each training session.
 5. A disk containing a separate Microsoft PowerPoint file for each training session. Name each file with its respective training session number.
 6. Other materials used in support of the lesson.
 7. One complete student handout package.
 8. One copy of material referenced in the lesson.

- C. Electronic Format for Review:
1. Create a bookmark for the one page summary, the table of contents, the introduction, and one for each training session.
 2. Include a PDF version of the PowerPoint slides for each training session.
 3. Other materials used in the lesson. Materials that have already been submitted separately, such as O&M Manuals, do not need to be submitted with the Instructor Guide.
- D. Final Hard Copy Format:
1. Pages: 8-1/2 inches by 11 inches in size or folded to that size.
 2. Binders: Heavy duty, D-ring, locking, three-ring binders not filled to more than 2/3 of their capacity.
 3. Paper: 47 pound bond.
 4. Include a heavy-duty plastic CD holder sized to fit in the three-ring binder and include one Power Point disk with each Instructor Guide.
- E. Each section of the Instructor Guide, representing one training session, must include the following information in the order listed below:
1. A short summary section including the following:
 - a. Training session number.
 - b. Lesson name: Concise but descriptive of what is included.
 - c. Estimated time to teach: This is an approximate period that may vary due to student number and knowledge level. It should correspond to the time listed in the training program summary at the beginning of the Instructor Guide.
 - d. Objectives: One or more performance-based objectives each of which specifies a measurable minimum level of performance considered acceptable.
 - e. Training session location, such as classroom, substation, or Shop facility.
 - f. Instructor materials needed for the training section, such as the following:
 - 1) Laptop and video projector
 - 2) PowerPoint Presentation
 - 3) Equipment, such as tools parts for disassembly
 - g. Trainee reference materials needed for that particular training session, in addition to the Training Manual, such as the following:
 - 1) O&M Manual
 - 2) As-Built Drawings
 - 3) Test equipment

2. A presentation section, including the following:
 - a. A short paragraph introducing the subject covered by the session.
 - b. A brief description of the lesson objectives.
 - c. A descriptive outline of all the topics to be included in the session, including the point at which to show each PowerPoint slide (reference slide number), certain sections of the O&M Manual (reference section and page number), certain drawings from the as-built drawings (reference drawing number), or other training materials.
 3. A closing section including any evaluations, tests, or quizzes given in conjunction with this lesson
- F. The Instructor Guide must be detailed enough to accomplish the following:
1. Serve as a written record of the specific facts and information.
 2. Allow another instructor with knowledge of the area to teach the class.
 3. Ensure that the subject delivery is consistent each time the lesson is given.
 4. Allow replication of all evaluations, tests, and quizzes given in conjunction with this lesson.

2.4 TRAINING MANUAL FOR TRAINEE'S USE

- A. The Training Manual will be furnished to each trainee, and must include the following:
1. The one-page training program summary from the Instructor's Manual.
 2. A table of contents.
 3. The introduction explaining the overall format for training from the Instructor's Manual.
 4. A separate section for each training session, similar to the Instructor's Manual but with the differences noted:
 - a. The summary section of the Instructor's Manual without the list of Instructor Materials.
 - b. The presentation section of the Instructor's Manual, but with full page power point slides added for each section at the end of the section.
- B. Electronic Format for Review:
1. Create a bookmark for the one page summary, the table of contents, the introduction, and one for each training session.
 2. Include a PDF version of the PowerPoint slides for each training session.
 3. Other materials used in the lesson. Materials that have already been submitted separately, such as O&M Manuals, do not need to be submitted with the Instructor Guide.
- C. Final Hard Copy Format:
1. Pages: 8-1/2 inches by 11 inches in size or folded to that size.

2. Binders: Heavy duty, D-ring, locking, three-ring binders not filled to more than 2/3 of their capacity.
3. Paper: 47 pound bond.

PART 3 - EXECUTION

3.1 TRAINING REPORTS

- A. Grading system: Establish to report progress of each trainee during the course and identify requirements for further training for each participant.
- B. Training Reports:
 1. Include graded tests (without names) with raw scores.
 2. Include a summary of the results of monitoring and evaluating.
 3. Include records of student attendance and performance.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

- A. The quantities of accepted work will be measured in the following units. All measurements will be plan measure except for authorized changes.
 1. Description: Lump Sum

4.2 PAYMENT

- A. Payment will be made at the respective unit or lump-sum price listed in the proposal and shall be full compensation for all labor, materials, and equipment necessary to complete the respective unit in place. There will be no separate measurement or payment for any item of work not specifically identified and listed in the proposal, and all such work shall be considered a subsidiary item with all costs pertaining thereto included in the prices for other items listed in the proposal. At the Engineer's option, partial payment may be made for any lump sum item listed in the proposal, providing that the Contractor is diligently and satisfactorily pursuing full completion of such partially complete item in accordance with the approved job progress schedule.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 34 22 05**TES COMMON WORK RESULTS FOR CONDUCTORS AND CABLE****PART 1 - GENERAL****1.1 SUMMARY**

- A. This Section includes the following:
 - 1. Products used with TES conductors and cable.
 - 2. Wire and cable type requirements.
 - 3. Requirements for circuit separation.
 - 4. Requirements for installation of TES conductors and cable for electrical power and traction power.
- B. This Section does not apply to the installation of OCS conductors.

1.2 RELATED SECTIONS

- A. SECTION 34 21 05 – Common Work Results for TES
- B. SECTION 34 21 90 – TES Testing
- C. SECTION 34 21 96 – TES Project Record Documents
- D. SECTION 34 22 29 – TES Raceway and Equipment Hangers and Supports

1.3 DEFINITIONS

- A. Low-voltage cable: A single or multi-conductor insulated cable rated 2000 V or less.

1.4 REFERENCED STANDARDS

- A. Section incorporates by reference the latest revisions of the following documents:
- B. Institute of Electrical and Electronics Engineers (IEEE)
 - 1. IEEE 1210, Standard Tests for Determining Compatibility of Cable-Pulling Lubricants With Wire and Cable
- C. National Electrical Contractors Association (NECA)
 - 1. NECA 1, Standard Practice of Good Workmanship in Electrical Contracting
- D. National Fire Protection Association (NFPA)
 - 1. NFPA 70, National Electrical Code
- E. Underwriters Laboratories (UL)
 - 1. UL 224, Extruded Insulating Tubing

1.5 SUBMITTALS

- A. Procedures: Section 01 33 00, Submittal Procedures.
- B. Submit Product Data on the following items:
 - 1. Cable pulling equipment, including tension measuring device with calibration certificate.
 - 2. Cable racks.
- C. Cable Pulling Calculations:
 - 1. Submit cable pulling calculations for approval no later than 30 working days before scheduled installation. Include the following information:
 - a. Circuit identification
 - b. Manufacturer and type of cable
 - c. Cable dimensions
 - d. Unit weight of cable
 - e. Maximum permissible pulling tension
 - f. Maximum permissible side-wall pressure
 - g. Pulling lubricant used and assumed friction coefficient.
 - h. Estimated length of pull
 - i. Recommended direction of pull
 - j. Total degrees of conduit bend
 - k. Inside radius and position in run of conduit bends
 - l. Conduit size
 - m. Calculated jam ratio
 - n. Calculated peak pulling tension
 - o. Calculated peak side-wall pressure
- D. Cable Pulling Report:
 - 1. Submit final report for each cable installation within 30 working days of installation and include the following information:
 - a. Information originally provided with Cable Pulling Calculations (see above)
 - b. Date of installation and name of Engineer's witness
 - c. Actual length of pull
 - d. Actual direction of pull
 - e. Actual maximum pulling tension

- f. Calculated maximum sidewall pressure at worst-case conduit ell and pulling sheave.
- E. As-built Drawings:
 - 1. Submit as specified in Section 34 21 96, TES Project Record Documents.
 - 2. Show splices in cable on as-built drawings.

1.6 NOTIFICATION

- A. Notify Engineer 48 hours before cable pulling operations where cable pulling calculations were required.
- B. Adjust schedule as necessary to permit observation.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Ship each unit securely wrapped, packaged, and labeled for safe handling in shipment and to avoid damage.
- B. Deliver wires and cables to the site in unbroken standard coils or reels with attached tag bearing manufacturer's name, wire trade name, and listing information.
- C. Store wire and cable in secure and dry storage facility, in accordance with NECA 1.

PART 2 - PRODUCTS

2.1 CONDUIT MANDREL AND BRUSH

- A. Mandrel: Flexible non-metallic segmented type.
 - 1. Size no smaller than 1/4 inch less than the size of conduit.
 - 2. Approved Manufacturer: Greenlee, or approved equal.
- B. Brush: Wire brush type, sized for conduit.

2.2 CABLE PULLING LUBRICANT

- A. Commercially-available non-petroleum-based product that will not damage cable sheathing or insulation or cause corrosion to metal boxes or fittings of the raceway system.
 - 1. Product shall be approved by the cable manufacturer.
 - 2. Product shall meet the requirements of IEEE 1210.
- B. Provide special-formulation pulling lubricant where required due to low ambient temperature or where a lower coefficient of friction is required to meet pulling tension and sidewall pressure limits.
- C. Acceptable Manufacturer/Product:
 - 1. Polywater J, or Polywater WJ for low ambient temperature, or approved equal.

2.3 CABLE RACKS

- A. UL listed, heavy duty, glass-reinforced nylon, suitable for the support of low voltage insulated cables without additional insulators, with sufficient load capacity to support the installed and future cables.
- B. Size: Racks shall be of adequate length to support the number of cables indicated without stacking, with space for 25 percent additional cables.

2.4 CABLE PROTECTORS

- A. Nylon, flanged, split tube to insert in duct end to protect cable from damage.
- B. Approved Manufacturers/Products:
 - 1. Greenlee 488-2 or 488-3;
 - 2. Condux 08042301 or 08042300; or approved equal.

2.5 INSULATED CABLE CLAMPS

- A. Thermoplastic elastomer, high-dielectric split-sleeve cable bushing and two-piece, galvanized or stainless-steel clamp assembly for installation on hot-dip galvanized framing channel.
- B. See Section 34 22 29, TES Raceway and Equipment Hangers and Supports, for framing channel requirements.
- C. Approved Manufacturer/Product: B-Line, Insulclamp, or approved equal.

2.6 CABLE SUPPORTS

- A. Designed to support cable in vertical conduit and provide a watertight seal.
- B. Malleable or ductile iron with hot-dip galvanized finish, threaded for rigid conduit.
- C. Approved Manufacturer/Product: OZ Gedney Cable Support, Type C Compound, or approved equal.

2.7 CABLE TIES (TIE WRAPS)

- A. Self-extinguishing nylon with a temperature range of minus 40 degrees F to 185 degrees F.
- B. Cable ties shall have a locking hub or head with a stainless steel locking barb on one end and a taper on the other end.
- C. Width:
 - 1. Dc feeder cables: Minimum 1/2 inch.
 - 2. Other applications: Adequate to prevent damage to wire or cable insulation.
- D. Strength: Minimum 250 pounds for dc feeder cables.
- E. Outdoor use: Ultraviolet-resistant material.

2.8 SPLICE AND TERMINAL CONNECTORS

- A. Fittings shall be tool-applied, compression, compatible with conductors on which they are used, and listed for use with provided cable.

- B. No. 10 AWG and smaller conductors:
 - 1. Wire terminations: Heavy duty, ring type, nylon insulated.
 - 2. Splices: Self-insulating or provided with an insulating cap or heat-shrink insulating sleeve.
- C. No. 8 AWG to No. 4 AWG: Provide double-bolted NEMA two-hole terminals where rotation of a single-bolted terminal would result in contact or unacceptable clearance with other conductors or the enclosure.
- D. No. 2 AWG to No. 3/0 AWG: Provide terminals with two NEMA-standard bolt holes in tongue unless otherwise indicated.
- E. No. 4/0 AWG and larger conductors: Provide long-barrel, double-compression type, with two NEMA standard bolt holes in tongue unless otherwise indicated.
- F. Compression Tools:
 - 1. Shall apply a hexagonal compression using mechanical, electrical, or hydraulic power mechanism that ensures a complete compression cycle.
 - 2. Shall permanently imprint die information on the completed connection.

2.9 INSULATING MATERIAL FOR SPLICES AND TERMINATIONS

- A. Provide insulating material for terminations of type accepted by Engineer for the particular use, location, and voltage. Mark each tape package to indicate shelf-life expiration date.
- B. Electrical insulating tape for general use: Vinyl plastic with rubber based pressure sensitive adhesive, pliable from temperatures of minus 18 degrees C to 105 degrees C. Verify tape has the following minimum properties when tested in accordance with ASTM D3005:
 - 1. Thickness: 7 mils.
 - 2. Breaking Strength: 15 pounds per inch.
 - 3. Elongation: 200 percent.
 - 4. Dielectric Strength: 10 kV/mil.
 - 5. Insulation Resistance (Direct method of electrolytic corrosion): 10 megohms.
- C. Rubber electrical insulating tape for protective overwrapping: Silicone rubber with a silicone pressure-sensitive adhesive. Verify tape has the following minimum properties when tested in accordance with ASTM D1000:
 - 1. Elongation: 525 percent.
 - 2. Dielectric Strength: 13 kV.
 - 3. Insulation Resistance (Indirect Method of Electrolytic Corrosion): 10 megohms.
- D. Heat shrink tubing: Product meeting the electrical and environmental requirements of the application.

2.10 FIREPROOFING TAPE

- A. Fire and arc proof tape, self extinguishing, and compatible with conductor insulation and jacket.
- B. Tape shall not deteriorate when subjected to water, salt water, gases or sewage.
- C. Approved Manufacturer/Product: 3M, Type 77, or approved equal.

2.11 IDENTIFICATION

- A. Wire Sleeves: Non-fading, heat-shrink polyolefin, machine-printed sleeve labels.
 - 1. Approved Manufacturer/Product: Brady PermaSleeve.
 - 2. Material: Polyolefin heat shrinkable tubing.
 - 3. Standards: UL 224.
 - 4. Color: White with black printing, unless specified or indicated otherwise.
- B. Cable Tags: Non-fading, polyethylene, slide in, printed cable tags with holes for attachment to cable with plastic cable ties.
 - 1. Numbers shall be 1-inch high.
 - 2. Approved Manufacturer/Product: Almetek Industries, Inc., E-Z Tags, or approved equal.

PART 3 - EXECUTION**3.1 WIRE AND CABLE TYPE REQUIREMENTS**

- A. Substation power circuits, ac and dc: 600 V single conductor cable.
- B. Within switchgear, where not exposed to medium voltage: 600 V switchboard wire.
- C. Within ac switchgear: 600 V switchboard wire.
- D. Within dc switchgear and rectifier: 2 kV switchboard wire.
- E. Dc feeders: 2 kV single-conductor dc feeder cable.
- F. Conductors installed in the same raceway or vault as 2 kV feeder cables (e.g. blue light conductors): 2 kV control wire.
- G. Control wiring to dc disconnect switches: 2 kV control wire.
- H. Cable sizes up to 4/0 AWG in cable tray: Multi-conductor cable.
- I. Surge arresters: Extra-flexible cable.
- J. Use bare conductor for ground wire only.

3.2 CIRCUIT SEPARATION

- A. Physically separate conductors and cables on circuits of different voltages or systems to reduce the possibility of unsafe conditions, interference, or equipment damage.

- B. The following major circuit groups shall not be harnessed or bundled together, shall not run in the same conduit and shall be physically separated and secured in vaults, enclosures, and cable trays.
1. Low-voltage ac circuits.
 2. Low-voltage dc circuits: 600 V rated.
 3. Low-voltage dc circuits: 2 kV rated.
 4. Dc control circuits.
 5. Dc traction power positive feeders.
 6. Dc traction power negative feeders.
- C. Where these circuit groups share vaults, enclosures, or cable trays, physically separate and secure such that there is a minimum separation of 6 inches.
- D. Where dc traction power positive and negative feeders share the same vault, rack them on opposite sides of the vault.

3.3 MANDRELLING RACEWAYS

- A. Mandrel and brush raceways before installing cable.

3.4 INSTALLING CABLE IN RACEWAY

- A. General Requirements:
1. Notify the Engineer 48 hours before installing cables.
 2. Inspect wire and cable for damage before installation. Damaged cable shall not be installed.
 3. Cable shall not exceed fill limits of NFPA 70.
 4. Install all cables to be placed in one duct simultaneously.
 5. Install conductors and cables in accordance with NECA 1 and as recommended by the manufacturer.
 6. Use extreme care in installing cables so as to avoid twisting, kinking, or injuring cable or its sheath.
 7. Apply generous amounts of approved cable pulling lubricant.
 8. Use an approved wire cable grip extending not less than 18 inches back from the end of the cable.
 9. Do not bend cables during installation, either permanently or temporarily, to radii less than 12 times the outer diameters, except where conditions make the specified radius impractical and shorter radii are permitted by the manufacturer.
 10. Immediately seal ends of cable until cable is terminated and protected in manholes.

- B. Cable Pulling Calculations:
1. Perform and submit cable pulling calculations before installing cable in raceways. Refer to Submittals Article, above, for documentation requirements.
 2. Perform calculations using industry-accepted pulling software such as PolyWater's 'Pull-Planner.'
 3. Calculate Jam Ratio, maximum pulling tension, and maximum side-wall pressure to ensure cable installation will meet manufacturer's requirements.
 4. If cable pulling calculations indicate that manufacturer-recommended installation tension or sidewall pressure may be exceeded, recalculate after making one or more of the following changes, as needed, until calculated tension and sidewall pressure are acceptable:
 - a. Modify pulling method.
 - b. Reverse pulling direction.
 - c. Provide special pulling lubricant.
 - d. Modify raceway components.
 - e. Add vaults or pull-boxes so that installation will be acceptable.
 5. If Jam Ratio indicates a tendency for cables to jam, provide factory- or field-installed cable-wrap or binding before installation or provide factory-multiplexed cables so that jamming will not occur.
 6. Revisions to raceway system, cables, or pulling method shall be made at no cost to Owner.
- C. Pulling Tension:
1. Do not exceed manufacturer's recommended pulling tension and sidewall pressure for cable installed.
 2. Tensiometer: Provide a calibrated tensiometer that indicates pulling force in pounds at the pulling end under the following circumstances:
 - a. Conduit runs with over 180 degrees of bend, whether pulled by hand or with a cable puller.
 - b. All cable installations where a cable puller is used, whether powered or unpowered.
 3. During cable installation, record the highest cable tension.
 4. Using measured cable tension, calculate the highest resulting sidewall pressure, both within conduit run and at pulling sheaves.
 5. Exceeding manufacturer's recommendations for either parameter will require replacement of cables at no cost to the Owner.
- D. Installation with power winches:
1. Power winches shall not be used for pulling conductors smaller than 2 AWG in raceways.

2. Provide suitable installation equipment to prevent cutting and abrasion of conduits and wire.
 3. If used, sheaves and pulleys must limit cable sidewall pressure and bend radius to acceptable values.
 4. Use lubricant and installation procedures as recommended by the cable manufacturer and suitable for expected ambient temperatures.
 5. Where conductors are pulled using more than three persons at the pulling end, meet requirements for installation with power winches.
- E. Installation in Manholes and Pullboxes:
1. Pump water out of manholes, hand holes, and pull chambers before installing cable and maintain manholes, hand holes, and pull chambers in a dry condition while cables are being pulled.
 2. Brush or swab dry and mandrel each conduit before installing cable.
 3. Install cables in the lowest available duct.
 4. Route cables along the manhole or handhole walls providing the longest possible slack or in accordance with approved installation drawings. Form cables closely parallel to the walls.
 5. Prevent cable interference with duct entrances.
 6. Provide cable racks spaced at a maximum of 4 feet and secure cable to racks using cable ties.
 7. Existing manholes and handholes: Where new ducts are to be terminated or where new cables are to be installed, modify the existing locations of cables, cable supports, and grounding as required to provide a properly arranged and supported installation.
- F. Cable Pulling Report: After cable installation, prepare and submit for approval a Cable Pulling Report documenting conditions during cable installation. Refer to Submittals Article, above, for documentation requirements.
- G. Bundle cable and conductors neatly and securely with nylon cable ties in branch circuit panelboards, cabinets and control boards. Bundle power cables separately from control cables.

3.5 INSTALLING SPLICES AND TERMINATIONS

- A. Use continuous lengths of wire and cable between power source and equipment. Splices are subject to approval by Engineer.
- B. Install splices and terminations in accordance with the cable and terminator manufacturers' instructions.
- C. Where splices are required and approved by Engineer, make them only in approved outlet, junction or pull boxes, or in equipment cabinets.
- D. Splice multi-conductor cables in accordance with the cable and splice-kit manufacturers' recommendations.

- E. Tools:
1. Use compression splice and terminator installation tools and installation techniques recommended by the manufacturer and as specified above.
 2. Conductor sizes through No. 6 AWG: Mechanical hand tools may be used, with dies for each conductor size as recommended by the manufacturer.
 3. Conductor sizes larger than No. 6 AWG: Use hydraulic tools with hexagonal or circumferential dies as recommended by the manufacturer.
 4. Insulate splices to a level equal to that of the cable.
 5. Fixture Wire: Make splices in lighting circuits with insulated crimp-type connectors.
 6. Control and Switchboard Wires: Terminate each wire held with screw-type terminals using an insulated sleeve (nylon), ring-tongue-type or locking spade-type, crimp-on lugs.
- F. Torque bolted connections with a calibrated torque wrench to values specified in Section 34 21 05, Common Work Results for TES.

3.6 FIREPROOFING DC FEEDERS

- A. Provide fireproofing tape in manholes, handholes, cable vaults, switchgear, and where exposed in other locations.
- B. Tape each conductor individually.
- C. Conductors that make up a single circuit may be taped as a group in intermediate vaults only when all three of the following conditions are satisfied:
1. The cables have twisted during installation such that it is impossible to tape each individual conductor.
 2. The cables are not spliced in the vault in question
 3. The Engineer agrees that it is impossible to tape each individual conductor at that location.
- D. Under no conditions shall conductors from different circuits be taped together as a group.

3.7 IDENTIFICATION

- A. Identify conductors cables at all terminal points and duct entrances at junction boxes, switches, circuit breakers, and pullboxes with tags as specified.
- B. Engineer will furnish cable numbering system.
- C. Wire sleeves: Print cable destination and number of conductors in cable as described in Contract Drawings.
- D. Wire and Cable tags: Attach with plastic tie wraps.

3.8 FIELD QUALITY CONTROL

- A. Cable Pulling Report: For installations where cable pulling calculations were required, provide cable tension measuring equipment and record the highest cable tension experienced during the installation. Submit Cable Pulling Report for approval.

- B. Wire and Cable Field Testing: Perform in compliance with Section 34 21 90, TES Testing.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

- A. The quantities of accepted work will be measured in the following units. All measurements will be plan measure except for authorized changes.
1. Description: Lump Sum

4.2 PAYMENT

- A. Payment will be made at the respective unit or lump-sum price listed in the proposal and shall be full compensation for all labor, materials, and equipment necessary to complete the respective unit in place. There will be no separate measurement or payment for any item of work not specifically identified and listed in the proposal, and all such work shall be considered a subsidiary item with all costs pertaining thereto included in the prices for other items listed in the proposal. At the Engineer's option, partial payment may be made for any lump sum item listed in the proposal, providing that the Contractor is diligently and satisfactorily pursuing full completion of such partially complete item in accordance with the approved job progress schedule.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 34 22 10**TES LOW-VOLTAGE CONDUCTORS AND CABLE****PART 1 - GENERAL****1.1 SUMMARY**

- A. This Section includes the following:
 - 1. Low-voltage wire and cable
 - 2. Dc traction power cable
 - 3. Extra-flexible cable, bare and insulated
 - 4. Wiring connections, splices, and terminations

1.2 RELATED SECTIONS

- A. SECTION 34 21 90 – TES Testing
- B. SECTION 34 21 96 – TES Project Record Documents
- C. SECTION 34 22 05 – TES Common Work Results for Conductors and Cable

1.3 DEFINITIONS

- A. Low-voltage cable: A single or multi-conductor insulated cable rated 2000 V or less.

1.4 REFERENCED STANDARDS

- A. Section incorporates by reference the latest revisions of the following documents:
- B. ASTM International (ASTM)
 - 1. ASTM B3, Specification for Soft or Annealed Copper Wire
 - 2. ASTM B8, Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
 - 3. ASTM B33, Standard Specification for Tinned Soft or Annealed Copper Wire for Electrical Purposes
 - 4. ASTM B172, Standard Specification for Rope-Lay-Stranded Copper Conductors Having Bunch-Stranded Members, for Electrical Conductors
 - 5. ASTM B496, Standard Specification for Compact Round Concentric-Lay-Stranded Copper Conductors
 - 6. ASTM D747, Standard Test Method for Apparent Bending Modulus of Plastics by Means of a Cantilever Beam
 - 7. ASTM D1000, Test Methods for Pressure-Sensitive Adhesive-Coated Tapes Used for Electrical and Electronic Applications
 - 8. ASTM D3005, Specification for Low-Temperature Resistant Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape

- C. Insulated Cable Engineering Association (ICEA)
 - 1. ICEA S-73-532/NEMA WC57, Standard for Control, Thermocouple Extension, and Instrumentation Cables
 - 2. ICEA S-95-658/NEMA WC 70, Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy
- D. Institute of Electrical and Electronics Engineers (IEEE)
 - 1. IEEE 1202, Standard for Flame-Propagation Testing of Wire and Cable
- E. InterNational Electrical Testing Association, (NETA)
 - 1. ANSI/NETA ATS, Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems
- F. International Organization for Standardization (ISO)
 - 1. ISO 9001, Quality Management Systems - Requirements
- G. National Electrical Contractors Association
 - 1. NECA 1, Standard Practices for Good Workmanship in Electrical Contracting
- H. National Fire Protection Association
 - 1. NFPA 70, National Electrical Code
- I. Underwriter's Laboratories (UL)
 - 1. UL 44, Thermoset-Insulated Wires and Cables
 - 2. UL 1277, Electrical Power and Control Tray Cables with Optional Optical-Fiber Member
 - 3. UL 1581, Reference Standard for Electrical Wires, Cables, and Flexible Cords

1.5 SUBMITTALS

- A. Procedures: Section 01 33 00, Submittal Procedures.
- B. Submit Product Data on the following items:
 - 1. Wire and cable of each type.
 - 2. Splicing and terminating materials.
- C. Product information for each type and size of wire and cable shall include the following:
 - 1. Manufacturer of wire and cable, and certificate of compliance.
 - 2. Number and size of strands composing each conductor.
 - 3. Conductor insulation composition and thickness.
 - 4. Average overall diameter of finished wire and cable.
 - 5. Storage instructions.
 - 6. Minimum training radius, in inches.

7. Minimum insulation resistance in megohms per 1000 feet at 30 degrees C ambient.
 8. Jacket composition and thickness in mils.
 9. Total number of conductors per cable.
 10. Shield material (if any) and thickness.
 11. Conductor resistance and reactance in ohms per 1000 feet at 25 degrees C ambient.
 12. Conductor ampacity at 30 degrees C ambient for 600 V wire and cable.
- D. Submit Test Procedures and Test Reports:
1. Certified test reports for Design Tests, Production Tests, and Flame Tests.
 2. Test procedures, including details of proposed test equipment.
 3. Field Test Report, including the following:
 - a. Continuity test.
 - b. Phase test for three-phase circuits.
 - c. Insulation resistance test.
- E. As-built Drawings:
1. Submit as specified in Section 34 21 96, TES Project Record Documents.
 2. Show splices in low-voltage cable, where permitted by Engineer, on as-built drawings.

1.6 QUALITY ASSURANCE

- A. Comply with the requirements of the Project Quality Plan.
- B. Qualifications: Cable manufacturer shall have a minimum of five years experience successfully manufacturing the type of cable to be supplied by that manufacturer.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. See Section 34 22 05, TES Common Work Results for Conductors and Cable.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. Wire and Cable Marking: Verify that wire and cable markings comply with applicable NEMA and NFPA 70 requirements.

2.2 600 V SINGLE CONDUCTOR WIRE AND CABLE

- A. Conductor Material: ICEA stranded or solid copper meeting requirements of ASTM B3, soft drawn.

- B. Conductor Type:
 - 1. Size 12 AWG and Smaller: Solid conductor.
 - 2. Size 10 AWG and Larger: Class B stranded.
- C. Insulation:
 - 1. Size No. 14 to 1/0 AWG: Type XHHW-2, cross-linked polyethylene insulated in accordance with ICEA S-95-658/NEMA WC 70.
 - 2. Size 2/0 AWG and Larger: Type XHHW-2, cross-linked polyethylene insulated in accordance with ICEA S-95-658/NEMA WC 70 or type RHH/RHW, ethylene-propylene-rubber-insulated in accordance with ICEA S-95-658/NEMA WC 70.
 - 3. Voltage Rating: 600 V.
 - 4. Temperature Rating: Insulation temperature rating not less than 90 degrees C in wet or dry locations.

2.3 600 V SWITCHBOARD WIRE

- A. Conductor: Stranded, tinned, annealed copper per ASTM B33.
- B. Insulation: Thermoset, chemically cross-linked polyethylene, UL Type SIS, 90 degrees C. Flame rated per UL 1581, Vertical Flame (VW-1).

2.4 2 KV SWITCHBOARD WIRE

- A. Conductor: Annealed, tinned copper per ASTM B33, flexible-stranded per ASTM B172.
- B. Insulation: Flame-retardant, crosslinked polyolefin, rated 2000 V, 110 C, 45 mil minimum thickness.
- C. Acceptable Manufacturer/Product: Rockbestos Exane-1068A, or approved equal.

2.5 2 KV CONTROL WIRE

- A. Conductor: Stranded, tinned, annealed copper per ASTM B33.
- B. Insulation: Thermoset, cross-linked polyethylene or ethylene propylene meeting the requirements of ICEA S-73-532/NEMA WC57, rated 2000 V, 90 degrees C wet or dry, single- or multi-conductor, suitable for installation in raceway.

2.6 2 KV SINGLE-CONDUCTOR DC FEEDER CABLE

- A. General:
 - 1. Type RHW-2, 90 degrees C, unshielded, size as indicated.
 - 2. Insulation and jacket system shall be rated for application up to 2 kV.
 - 3. Cable shall be suitable for use on service and feeders, indoors or outdoors, in wet or dry locations, or in raceway/duct. Cable shall be sunlight resistant and suitable for installation at 0 degrees C and in cable tray.
 - 4. Cables shall meet or exceed the requirements of ICEA S-95-658/NEMA WC 70, UL 44, and UL 1581.

5. Cable shall be manufactured and tested under the control of a Quality Assurance program that meets the requirements of ISO 9001.
- B. Conductors: Annealed, uncoated copper, round or compact, concentric-lay stranded per ASTM B496.
 - C. Insulation: Ethylene-propylene rubber (EPR) meeting electrical and physical requirements of ICEA S-95-658/NEMA WC 70.
 1. No polyethylene shall be allowed as a component of the insulation and EPR insulation shall be compounded by the cable manufacturer.
 2. For flexibility, the insulation compound shall have an Apparent Bending Modulus of 2600 psi or less in accordance with Standard Test Method ASTM D747.
 - D. Overall Sheath Jacket: Thermosetting chlorinated polyethylene unless noted otherwise.
 - E. Approved Manufacturer/Product: The Okonite Company, Okoguard-Okolon TS-CPE, or approved equal.

2.7 EXTRA-FLEXIBLE CABLE

- A. Conductor: Copper; Class I stranding, or as indicated; ASTM B3, ASTM B172; bare or insulated.
- B. Insulation:
 1. Type RHW-2, 90 degrees C, unshielded, rated 2 kV, size as indicated.
 2. Ethylene-propylene rubber (EPR) as specified above under 2 kV single-conductor cable.

2.8 MULTI-CONDUCTOR, LOW-VOLTAGE CABLE

- A. Provide multi-conductor cable conforming to ICEA S-95-658/NEMA WC 70, approved for use in cable tray, with the following additional requirements:
 1. Conductors: Bare, soft annealed copper per ASTM B33, Class B stranded in accordance with ASTM B8. Quantity of conductors as indicated.
 2. Insulation: As specified above for single conductor cable.
 3. Overall Covering: Cable shall be provided with sunlight-resistant jacket over the insulation meeting the flame-spread requirements of UL 1277.
 4. Multiple conductors for control wire shall be minimum of 14 AWG stranded copper.
 5. Insulation Rating: 600 V.
- B. Multi-conductor cable shall be made by assembling individual or twisted pairs of insulated conductors into a tight cylindrical form using fillers that are compatible with other materials in the cable. The jacket used shall fit tightly to form a firm assembly.

2.9 FIXTURE WIRE

- A. Provide fixture wire conforming to the following requirements:
 1. Type: SF-2 silicone rubber insulated.
 2. Conductor: Stranded copper conductor 16 AWG or larger as indicated.

2.10 BARE CONDUCTOR

- A. ASTM B3, Class B stranded, annealed soft-drawn copper conductor unless otherwise indicated. Size as indicated.

2.11 COLOR CODING OF CONDUCTORS (600 V)

- A. Identify individual conductors of multi-conductor cables by means of solid colors, stripes, or printing, unless otherwise approved by Engineer.
- B. Jacket Printing: Mark conductors in compliance with NFPA 70, and with the following additional information:
 - 1. Number of conductors (for multi-conductor cables).
 - 2. Date of manufacture.
- C. Footage Marker: Provide the following cable types with footage printing on the jacket or a footage marker tape under the jacket.
 - 1. Multi-conductor cables.
- D. Ac Power Cables: Conform to the following color coding for power cables:

Conductor	480Y/277 V	208Y/120 V
Phase A	Brown	Black
Phase B	Orange	Red
Phase C	Yellow	Blue
Neutral	White	White
Ground	Green	Green

- E. Use solid color insulation or solid color coating for branch circuit phase conductors No. 10 AWG and smaller and neutral and equipment ground conductors.
- F. Use a background color other than white or green for phase conductors with colored tracers.

2.12 FACTORY ASSEMBLY

- A. Wire and cable type requirements: See Section 34 22 05, TES Common Work Results for Conductors and Cable.
- B. Circuit Separation: See Section 34 22 05, TES Common Work Results for Conductors and Cable.
- C. Install wires and cables in accordance with manufacturer's recommendations and restrictions.
- D. Do not bend cables during installation, either permanently or temporarily, to radii less than 12 times the outer diameters, except where conditions make the specified radius impractical and shorter radii are permitted by the manufacturer.
- E. Bundle cable and conductors neatly and securely with cable ties in branch circuit panelboards, cabinets and control boards. Bundle power cables separately from control cables.
- F. Install wire and cable in conduit as indicated and in accordance with NECA 1.

- G. Terminations:
1. Use continuous lengths of wire and cable between power source and equipment. Splices are not permitted.
 2. Tools:
 - a. Use terminator installation tools and installation techniques recommended by the manufacturer.
 - b. Conductor sizes through No. 6 AWG: Mechanical hand tools may be used, with dies for each conductor size as recommended by the manufacturer.
 - c. Conductor sizes larger than No. 6 AWG: Use hydraulic tools with hexagonal or circumferential dies as recommended by the manufacturer.
 - d. Use compression tools that permanently imprint die information on the completed connection.
 3. Control and Switchboard Wires: Terminate each wire held with screw-type terminals using an insulated sleeve (nylon), ring-tongue-type or locking spade-type, crimp-on lugs.
- H. Wiring Within Enclosures:
1. Requirements below apply to all electrical equipment enclosures, including junction boxes.
 2. General:
 - a. Install wire as continuous lengths inside substations, without splices between terminations.
 - b. Wiring entering a removable enclosure shall be harnessed and secured to facilitate removal.
 - c. Wires from different wire runs shall not be harnessed together or with internal wiring.
 3. Wire support:
 - a. Attach wiring within enclosures to conductor supports rigidly fastened to the enclosure structure.
 - b. Wiring supports shall be free from edges, bolt heads, or similar areas and shall not interfere with nor contact enclosure covers.
 - c. Secure wiring such that there is no strain on wire terminals, multi-pin connector pins, or other wire termination hardware.
 - d. Use of adhesive wire supports is not permitted.
 4. Wire dress:
 - a. Allow sufficient slack at terminals to accommodate vibration, equipment shifting, cover removal, and component replacement.

- b. Provide additional wire length for re-termination of wires without excess tension or splicing as follows:
 - 1) No. 10 and smaller: Three re-terminations.
 - 2) No. 8 and larger: Two re-terminations.
- 5. Terminal blocks: Provide with insulated covers.
- 6. Cubicle doors: Protect wires at hinges.

2.13 SOURCE QUALITY CONTROL

A. Design Tests:

- 1. 2 kV Single-Conductor Dc Feeder Cable:
 - a. Cable shall meet the requirements of the following flame test procedures:
 - 1) UL 44 vertical tray flame test.
 - 2) IEEE 1202 for 1/0 AWG & larger.
- 2. Multi-Conductor 600 V Type TC Control Cable:
 - a. Flame Test: Completed cable shall pass the UL 1581 vertical tray flame test for cable assemblies.

B. Production Tests:

- 1. 2 kV single-conductor dc feeder cable: Perform on each reel of 2 kV single conductor dc feeder cable.
 - a. High voltage ac withstand test: Perform at the potential indicated in the table below after six hours immersion in water and while still submerged. Hold voltage for 5 minutes.

Conductor Size (AWG/kcmil)	Wall Thickness (min average)		Withstand Voltage (kVac)
	EPR	TS-CPE	
8-2	55	30	7.0
1-4/0	65	45	8.0
250-500	75	65	9.5
550-1000	90	65	11.5

- b. Insulation Resistance Test: The insulation resistance constant shall not be less than 15,000 megohms per1000 feet at 15.6 degrees C.
- 2. Submit certified test reports documenting production testing.

PART 3 - EXECUTION

3.1 WIRE AND CABLE TYPE REQUIREMENTS

- A. See Section 34 22 05, TES Common Work Results for Conductors and Cable.

3.2 FIELD INSTALLATION

- A. See Section 34 22 05, TES Common Work Results for Conductors and Cable.

3.3 FIELD QUALITY CONTROL

- A. See Section 34 21 90, TES Testing, for field testing for wire and cable.

PART 4 - MEASUREMENT AND PAYMENT**4.1 MEASUREMENT**

- A. The quantities of accepted work will be measured in the following units. All measurements will be plan measure except for authorized changes.
1. Description: Lump Sum

4.2 PAYMENT

- A. Payment will be made at the respective unit or lump-sum price listed in the proposal and shall be full compensation for all labor, materials, and equipment necessary to complete the respective unit in place. There will be no separate measurement or payment for any item of work not specifically identified and listed in the proposal, and all such work shall be considered a subsidiary item with all costs pertaining thereto included in the prices for other items listed in the proposal. At the Engineer's option, partial payment may be made for any lump sum item listed in the proposal, providing that the Contractor is diligently and satisfactorily pursuing full completion of such partially complete item in accordance with the approved job progress schedule.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 34 22 15

TES FIBER OPTIC CABLE

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Outside plant single mode fiber optic cable for transfer trip between TES substations.
 - 2. Patch panel for fiber optic cable.

1.2 RELATED SECTIONS

- A. SECTION 26 05 43 – Systemwide Electrical Underground Ductbanks and Raceways for Systems
- B. SECTION 34 21 06 – TES Common Work Results for Metals
- C. SECTION 34 21 31 – TES Substation Automation System
- D. SECTION 34 21 90 – TES Testing
- E. SECTION 34 22 05 – TES Common Work Results for Conductors and Cable
- F. SECTION 34 22 33 – TES Raceway and Boxes

1.3 DEFINITIONS

- A. See RUS Bulletin 1753F-601a.

1.4 REFERENCED STANDARDS

- A. Section incorporates by reference the latest revisions of the following documents:
- B. ASTM International (ASTM)
 - 1. ASTM D1248, Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable
- C. U.S. Department of Agriculture, Rural Utilities Service (RUS)
 - 1. RUS Bulletin 1753F-601a (PE-90a), Minimum Performance Specification for Fiber Optic Cables
- D. National Fire Protection Association (NFPA)
 - 1. NFPA 70, National Electrical Code (NEC)
- E. National Electrical Contractors Association (NECA)
 - 1. NECA 301, Installing and Testing Fiber Optics

- F. International Organization of Standardization (ISO)
 - 1. ISO 9001 Standard Quality Management Systems
- G. Telecordia
 - 1. GR-326, Generic Requirements for Single-Mode Optical Connectors and Jumper Assemblies
- H. Telecommunications Industry Association (TIA)
 - 1. TIA-598, Optical Fiber Cabling Coding

1.5 SUBMITTALS

- A. Procedures: Section 01 33 00, Submittal Procedures.
- B. Product Data:
 - 1. Fiber optic cable.
 - 2. Connectors.
 - 3. Splice kits.
- C. Certificates of compliance with specified standards.
- D. Cable identification schedule.
- E. Qualifications:
 - 1. Manufacturer.
 - 2. Foreman for fiber optic cable installation.
 - 3. Splicing technicians.
- F. Installation:
 - 1. Installation plan.
 - 2. Manufacturer's cable installation requirements, including maximum pulling tension, minimum bend radius under tension, minimum final bend radius, and recommended installation methods.
 - 3. Pulling calculations, if cable is pulled.
 - 4. Cable pulling report, if cable is pulled.
 - 5. Manufacturer's installation instructions:
 - a. Connectors.
 - b. Splice kits.
- G. Testing:
 - 1. Test procedure complying with Section 34 21 90, TES Testing.
 - 2. Test report complying with Section 34 21 90, TES Testing, for each segment tested.

1.6 QUALITY ASSURANCE

- A. Comply with the requirements of the Project Quality Plan.
- B. Qualifications:
 - 1. Manufacturer:
 - a. Minimum 5 years of demonstrated experience manufacturing fiber optic cable and minimum 2,000,000 feet of fiber optic cable supplied and successfully installed.
 - b. Quality Assurance Program in place conforming to requirements of ISO 9001.
 - 2. Foreman of fiber installation crew: Minimum 2 years experience installing fiber optic cables in duct systems.
 - 3. Splicing technicians:
 - a. Minimum 2 years prior experience installing, splicing, and testing single-mode fiber optic cable
 - b. Certified fusion splicing technicians with a demonstrated knowledge of industry standards, fiber optic splicing and fiber optic testing equipment.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Packing:
 - 1. Ship cable on non-returnable wooden reels.
 - 2. Drum Diameter: Minimum 20 times the diameter of cable.
 - 3. Reels: Substantial enough to withstand reasonable handling, designed with inner end of accessible but protected from injury.
 - 4. Cable Ends: Sealed to prevent entrance of moisture and securely fastened to prevent ends from becoming loose during transit.
- B. Ship each run of cable on a separate reel.
- C. Clearly identify each cable reel on the outside flange with the following information:
 - 1. Manufacturer's name.
 - 2. Contract name and number.
 - 3. Cable identification number.
 - 4. Cable length.
 - 5. Date of manufacture.
 - 6. Name, address, and phone number of consignee.
- D. Delivery:
 - 1. Inspect cables at time of delivery at construction site to assure no damage was done during shipping.

2. Inspect every reel for physical damage.
- E. Storage:
1. Store cables on solid surfaces designed to support cable reels which drain adequately and do not allow accumulation of liquids, oils, or chemicals.
 2. Align and protect cable reels so as not to allow reel flanges to damage other reels.
 3. Reseal cable ends promptly when a length is cut from reel.
- F. Handling:
1. Handle cable reels using a sling and spreader attached to a shaft through the reel hubs, or by cradling both flanges between lift truck forks.
 2. Do not lift reels by top reel flange or drop from any height.
 3. Ensure lift truck forks do not touch cable surfaces on reel.
 4. Roll reels in the direction opposite the cable wind on reel.
 5. Do not lay reels flat.

PART 2 - PRODUCTS

2.1 OUTSIDE PLANT FIBER OPTIC CABLE

- A. General:
1. The life expectancy of the cable shall be 25 years for service in a railroad and transit environment.
 2. The cable shall be designed for installation in underground conduit, wet or dry environments, including alternating wet and dry conditions.
- B. Cable Description:
1. Single mode, 12 fiber, all-dielectric, complying with requirements of RUS Bulletin 1753F-601a.
 2. Tensile strength: Minimum 600 pounds, sufficient for the intended installation method and the length of each run.
- C. Fiber: Optimized for wavelength and attenuation per equipment requirements, colored with ultraviolet curable inks complying with color coding of RUS Bulletin 1753F-601a.
- D. Cable Construction:
1. Gel-Filled Loose Tube Buffer:
 - a. Gel: Non-hygroscopic, anti-fungal, non-conductive, homogenous, free from dirt and foreign matter, and readily removable with conventional nontoxic solvents.
 - b. Buffer tube color coding shall comply with TIA-598.
 2. Central Strength Member: Dielectric, overcoated with thermoplastic.

3. Overall strength member: Aramid yarn.
4. Inner Jacket: Black polyethylene, separated from outer jacket by water blocking yarns for mechanical protection.
5. Outer Jacket:
 - a. Suitable for wet and dry locations, dust resistant, and gas tight.
 - b. Extruded low-density, high molecular weight polyethylene, black, complying with ASTM D1248, Type I, Category 5, Class C, Grade E5.
 - c. Permanently marked in accordance with RUS Bulletin 1753F-601a.
- E. Connectors: Comply with Telcordia GR-326.
- F. Cable Management Hardware: Specifically manufactured for cable management of fiber optic cable.
- G. Identification:
 1. Wire sleeves: Comply with requirements in Section 34 22 05 Common Work Results for Conductors and Cable.
 2. Cable tags: Weatherproof, polyolefin, machine printed, white with black lettering, for securing with cable ties. Lettering minimum 1/8-inch high.

2.2 FIBER PATCH PANEL

- A. Type: Rack mounted, unloaded.
- B. Configuration: Minimum 12 ports with connector bulkhead, space for storing 6 meters of each fiber optic cable, tie point for securing fiber cable central member, and effective management of fiber terminations.
- C. Identification: Labeling provisions that correspond to each fiber port location. Labeling shall be viewable from front of panel.
- D. Cable entrance: Provide grommet and cable clamp strain relief.

2.3 FIBER PATCH CORDS

- A. Patch Cord Cable Construction:
 1. Factory-fabricated, flexible fiber optic cable assembly with SC compatible connectors, from manufacturer's standard products lines.
 2. Shall contain a dielectric strength member and a protective outer jacket and allow for small bend radius for installation in space-constrained areas.
 3. Type: Single-Mode Duplex Zip cord.
 4. Acceptable Manufacturer: ADC Krone or approved equal.
- B. Jacket Color: Yellow for single mode.
- C. Connectors:
 1. SC UPC (blue) for patch panel ports.

2. Connector ends for field equipment shall match equipment optical port configuration.
- D. Fiber: Meet the same characteristic requirements of the patch-panel-terminated cable to which it mates.

PART 3 - EXECUTION

3.1 PRIOR TO INSTALLATION OF CABLE

- A. Submit installation plan indicating proposed installation method to Engineer for approval.
1. Installation by Blowing: Verify that conduit intended for use is properly installed for the intended blowing pressure.
 2. Installation by Pulling:
 - a. Submit pulling calculations for each segment in accordance with Section 34 22 05, TES Common Work Results for Conductors and Cable.
 - b. Verify that tensile strength of cable is greater than the calculated pulling tension.

3.2 INSTALLATION OF CABLE

- A. Raceway:
 1. Install cabling in raceway complying with Section 34 22 33, TES Raceway and Boxes, and 26 05 43, Systemwide Electrical Underground Ductbanks and Raceways for Systems. No exposed cabling will be allowed.
 2. Prime and paint exposed raceways in accordance with Section 34 21 06, TES Common Work Results for Metals, to match the color of the structure.
- B. Comply with cable installation requirements in NECA 301.
- C. Provide 50 feet of slack cable in the manhole closest to each substation.

3.3 AFTER INSTALLATION OF CABLE

- A. If cable was pulled, submit cable pulling report for each segment in accordance with Section 34 22 05, TES Common Work Results for Conductors and Cable.
- B. Identification:
 1. Submit a cable identification schedule to the Engineer for approval before applying cable labels.
 2. Identify interior cable and patch cords on both ends less than 3 inches from the termination using wire sleeves.
 3. Identify each cable using cable tags where it enters and leaves each manhole, handhole, or pull box through which it passes.
- C. Connector Installation: Comply with manufacturer's instructions.

3.4 WITHIN SUBSTATION

- A. Install patch panel in substation communications rack.

- B. Terminate outside plant fiber optic cable in patch panel.
- C. Provide fiber patch cords as required for the following applications:
 - 1. From port to port within same patch panel, for fiber cross-connection patching.
 - 2. From patch panel to SAS switch (see Section 34 21 31, TES Substation Automation System).
- D. Patch cords installed within ladder tray and at conduit to equipment transitions shall be installed in flexible corrugated innerduct for protection.

3.5 CABLE MANAGEMENT

- A. Provide horizontal and vertical cable management hardware for cables in manholes, racks, cable trays, and in switchgear.
- B. Perform the following using cable management:
 - 1. Organize cable, arranging it neatly and securely.
 - 2. Arrange cable such that it does not interfere with the future use of or access to unused conduit.
 - 3. Segregate different classes of cable, such as ac power, dc power, ground, and data.
 - 4. Make ports and designation strips visible.
 - 5. Provide permanent circuit identification for cables supported or terminated.

3.6 SPLICING AND TERMINATION

- A. Fiber splicing shall be performed by the fusion splicing method only and placed only in communication equipment enclosures in the substation.
- B. Fiber optic cable shall not be spliced in manholes or handholes unless specifically authorized.
- C. Splices and terminations shall be connectorized and supported in a cabinet or splice enclosure.

3.7 FIELD QUALITY CONTROL

- A. Inspect for the following:
 - 1. Conformance to workmanship standards and practices.
 - 2. Conformance to Contract Documents
 - 3. Correct and secure cabling terminations and connections.
 - 4. Correct and complete labeling and tagging.
- B. Field Testing:
 - 1. Submit test procedures complying with the requirements of Section 34 21 90, TES Testing.

2. Verify that test equipment bears a current calibration sticker, in accordance with Section 34 21 90, TES Testing, before scheduling testing.
 3. Test the following in each substation:
 - a. Power output of fiber optic transmitters
 - b. Sensitivity of fiber optic receivers
 4. Perform the following testing in accordance with NECA 301 after installing cable and installing identification in accordance with this Section:
 - a. Continuity testing.
 5. Perform the following in accordance with NECA 301 on each fiber after splicing is complete and cable is secured in its final position:
 - a. End-to-end insertion loss using an OLTS power meter and source.
 - b. OTDR test.
 6. Perform the following additional tests:
 - a. Bit error ratio: Must be minimum 10^{-13}
 - b. Transmission speed of each circuit.
 - c. Link failure transfer and restoration time
 7. Compare OLTS insertion loss to the loss estimated in the calculated loss budget and include in test report.
- C. Test transfer trip system in accordance with Section 34 21 90, TES Testing, as part of Field Acceptance Testing.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

- A. The quantities of accepted work will be measured in the following units. All measurements will be plan measure except for authorized changes.
1. Description: Lump Sum

4.2 PAYMENT

- A. Payment will be made at the respective unit or lump-sum price listed in the proposal and shall be full compensation for all labor, materials, and equipment necessary to complete the respective unit in place. There will be no separate measurement or payment for any item of work not specifically identified and listed in the proposal, and all such work shall be considered a subsidiary item with all costs pertaining thereto included in the prices for other items listed in the proposal. At the Engineer's option, partial payment may be made for any lump sum item listed in the proposal, providing that the Contractor is diligently and satisfactorily pursuing full completion of such partially complete item in accordance with the approved job progress schedule.

END OF SECTION

SECTION 34 22 20

TES RAIL BONDING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes power bonding, cross bonding, and rail connections for traction electrification system.

1.2 REFERENCED STANDARDS

- A. Section incorporates by reference the latest revisions of the following documents:
- B. International Organization for Standardization (ISO)
 - 1. ISO 9001, Quality Management Systems - Requirements
- C. Underwriter's Laboratories (UL)
 - 1. UL 467, Grounding and Bonding Equipment

1.3 SUBMITTALS

- A. Procedures: Section 01 33 00, Submittal Procedures.
- B. Product Data: Description and catalog cut of proposed components and hardware items to be provided including the following:
 - 1. Proposed stub-end bonds for each size cable to be used identifying part number, wire size, stranding, and terminations.
 - 2. Weld material.
 - 3. Exothermic weld molds for each type of application.
- C. Testing Documents:
 - 1. Submit rail bonding testing documents under this Section.

1.4 QUALITY ASSURANCE

- A. Comply with the requirements of the Project Quality Plan.
- B. Engineer will inspect bonds for conformance to these Specifications.
- C. Remove bonds rejected by Engineer that have been deemed poor quality by Engineer and replace with a new bond at Contractor's expense.
- D. Qualifications: Manufacturer of exothermic welding system shall be ISO 9001 certified.

PART 2 - PRODUCTS**2.1 EXOTHERMIC WELDING SYSTEM**

- A. Welding mixture: Copper based exothermic mixture designed for permanent grounding or bonding connections, approved for outdoor use, and meeting UL 467.
- B. Molds: Specifically designed for exothermic welding of cable to web of rail.
- C. Stub-End Bond: Pre-formed, extra-flexible stranded copper cable, designed to assist exothermic weld process to a rail web, sized for each cable type.
- D. Approved Manufacturers/Products:
 - 1. Erico, Cadweld;
 - 2. Continental Industries, Thermoweld; or approved equal.

PART 3 - EXECUTION**3.1 INSTALLATION**

- A. Connect negative returns to rail and provide crossbonding at locations shown on Contract Drawings.
- B. Install rail connections and bonding in accordance with approved procedures, installation drawings, and in accordance with manufacturer's recommendations.
- C. Maintain running rail electrical isolation from ground.

3.2 RAIL CONNECTIONS

- A. Heat rail to remove trapped moisture.
- B. Clean surfaces of rails with a vitrified grinding wheel before welding.
- C. Clean rails with "Inhibisol" or other approved nontoxic solvent to remove traces of dirt and debris from grinding operations.
- D. Exothermically weld stub-end bond to rail.
- E. Stagger at intervals of not less than 8 inches on centerline.
- F. Center bonds: Weld to web of rail within plus or minus 1/4 inch of neutral axis.
- G. Rail-weld inspection and test:
 - 1. Visually inspect each weld in accordance with manufacturer's manual on installation.
 - 2. Test each weld to rail by striking sharply with a 2-pound hammer.
 - 3. Test bond resistance: Maximum of (Bond Length (ft) x 0.000011 (ohms/ft)) + 0.00016 (ohms).
- H. Remove defective bonds.
- I. Repeat or broken welds due to misfires, poor fusion, or other causes shall be relocated a minimum of 4 inches on centerline from their original weld locations.

3.3 EXOTHERMIC SPLICE

- A. Exothermically weld rail connection stub-end bond to power cable.
- B. Do not connect splice until rail connection has passed visual inspection, hammer test, and resistance test.
- C. Provide sufficient slack to accommodate rail movement due to expansion and contraction.

PART 4 - MEASUREMENT AND PAYMENT**4.1 MEASUREMENT**

- A. The quantities of accepted work will be measured in the following units. All measurements will be plan measure except for authorized changes.
 - 1. Description: Lump Sum

4.2 PAYMENT

- A. Payment will be made at the respective unit or lump-sum price listed in the proposal and shall be full compensation for all labor, materials, and equipment necessary to complete the respective unit in place. There will be no separate measurement or payment for any item of work not specifically identified and listed in the proposal, and all such work shall be considered a subsidiary item with all costs pertaining thereto included in the prices for other items listed in the proposal. At the Engineer's option, partial payment may be made for any lump sum item listed in the proposal, providing that the Contractor is diligently and satisfactorily pursuing full completion of such partially complete item in accordance with the approved job progress schedule.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 34 22 26

TES GROUNDING AND BONDING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. TES substation ground grid.
 - 2. TES substation power system grounding, electrical equipment grounding, and raceway grounding.
 - 3. TES substation interior ground bus.

1.2 RELATED SECTIONS

- A. SECTION 34 21 16 – TES Substation Enclosures
- B. SECTION 34 21 90 – TES Testing
- C. SECTION 34 22 29 – TES Raceway and Equipment Hangers and Supports

1.3 REFERENCED STANDARDS

- A. Section incorporates by reference the latest revisions of the following documents:
- B. ASTM International (ASTM)
 - 1. ASTM B3, Specification for Soft or Annealed Copper Wire
 - 2. ASTM B187, Specification for Copper Bar, Bus Bar, Rod and Shapes
- C. Institute of Electrical and Electronics Engineers (IEEE)
 - 1. IEEE 837, Standard for Qualifying Permanent Connections Used in Substation Grounding
- D. National Fire Protection Association (NFPA)
 - 1. NFPA 70, National Electrical Code

1.4 SUBMITTALS

- A. Procedures: Section 01 33 00, Submittal Procedures.
- B. Product Data: Specified materials.
- C. Substation interior perimeter ground bus drawings:
 - 1. Provide plan view showing perimeter ground bus, equipment, and ground connections.
 - 2. Provide elevations of each wall showing height of perimeter ground bus and connections to equipment.

1.5 QUALITY ASSURANCE

- A. Comply with the requirements of the Project Quality Plan.
- B. Regulatory Requirements:
 - 1. Unless otherwise specified, electrical equipment and material shall be listed and labeled for the purpose for which it is used, by the Underwriters Laboratories, Inc. (UL).
 - 2. Installations shall be in accordance with NFPA 70.
- C. Qualifications: Persons installing exothermic welds shall be trained in their installation.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Ship each item of equipment and materials securely wrapped, packaged, and labeled for safe handling in shipment and to avoid damage.
- B. Store equipment and materials in secure and dry storage facility.

PART 2 - PRODUCTS**2.1 EQUIPMENT AND MATERIALS**

- A. Ground Rods:
 - 1. Copper-clad steel, non-rusting, sectional type.
 - 2. Size: Minimum 10 feet long and 3/4-inch diameter.
 - 3. Acceptable Manufacturer: Erico, or approved equal.
- B. Substation Ground bus:
 - 1. ASTM B187, 98 percent conductivity copper, silver plated.
 - 2. Size: 1/4-inch thick. Width depends on specific application (see Part 3, below).
- C. Stranded Bare Conductors: ASTM B3, Class B stranded, annealed copper conductor, unless otherwise indicated; size as indicated.
- D. Insulated Conductors: ASTM B3, Class B stranded, annealed copper conductor, type XHHW-2 unless otherwise indicated, green colored, size as stated or indicated.
- E. Terminal Lugs: Exothermically-welded or compression-type approved for the application.
- F. Jumpers: Tin-plated copper, braided, flexible jumper.
- G. Compression Connections: Connectors and compression tools of a single manufacturer. Connectors shall have an inspection port for use in checking proper conductor insertion.
- H. Compression Tools: For field quality control, compression tools shall not release before completion of the compression cycle and shall emboss the die index number into the connector as the crimp is completed.
- I. Bolted connectors: Burndy, or approved equal.
- J. Bolts for attachment of lug to equipment: Bronze.

- K. Exothermic Welding System:
 - 1. Provide dual-component exothermic welds with molds and accessories of a single manufacturer.
 - 2. Approved Manufacturers:
 - a. Erico;
 - b. Thermoweld; or approved equal.

2.2 FACTORY ASSEMBLY

- A. Raceway Ground:
 - 1. Assemble metallic conduits to provide a continuous ground path.
 - a. Bond metallic conduits using insulated grounding bushings.
 - b. Connect grounding bushings to the grounding system using conductors sized to comply with NFPA 70.
 - 2. Equipment Ground: In metallic and nonmetallic conduits where conductors are installed, provide a separate equipment grounding conductor, sized to comply with NFPA 70, Article 250, and installed in accordance with these Specifications.
- B. Equipment and Enclosure Grounds:
 - 1. Connect electrical and distribution equipment to the grounding system. Size cables or bus as specified.
 - 2. Connect non-electrical equipment with metallic enclosures to the grounding system.
 - 3. Bond boxes to the raceway or conduit system with a copper jumper solidly bolted to the box, sized to comply with NFPA 70.
- C. Equipment Grounding Requirements:
 - 1. Install a copper equipment grounding conductor in each raceway and bond to metallic raceways and boxes at access and pull points.
 - 2. Size equipment grounding conductors in accordance with NFPA 70 to provide adequate conduction path for ground faults. Increase size as required to allow for circuit voltage drop.
 - 3. Ground metallic raceways, boxes, cabinets, exposed expansion joints, lighting fixtures, motors, transformers and receptacles. Provide grounding bushings or compression connectors attached with machine screws for bonding.
- D. Substation Interior Perimeter Ground Bus:
 - 1. Provide 2-inch wide ground bus around entire perimeter of substation interior.
 - a. Mount on steel framing channel. See Section 34 22 29, TES Raceway and Equipment Hangers and Supports, for framing channel requirements.
 - b. Install at 18 inches above finished floor where there are no obstructions, and up to 8 feet above finished floor to avoid equipment or doorways.

2. Provide 1-inch wide ground bus from ac switchgear, ac surge arresters, panelboards, and other electrical equipment to perimeter ground bus.
3. Connect interior perimeter ground bus to four substation enclosure exterior grounding pads specified in Section 34 21 16, TES Substation Enclosures.

PART 3 - EXECUTION

3.1 FIELD INSTALLATION

- A. Requirements of Article titled "Factory Assembly" apply to field installation.
- B. Buried or embedded connections:
 1. Exothermically welded or compression-type terminal lugs using materials qualified in accordance with IEEE 837.
 2. Bolted connections shall not be buried or embedded.
- C. Above-ground connections:
 1. Exothermically welded or compression-type terminal lugs using materials qualified in accordance with IEEE 837.
 2. Bolted connections are permitted only in secured locations not accessible to the public.
- D. Connections shall be made in accordance with the manufacturer's requirements.
- E. Clean ferrous structures and piping and coat with minimum 6 mils thick zinc-rich primer for a distance of 6 inches from the grounding attachment point.
- F. Do not bond buried metallic piping systems or structures to grounding electrode systems unless specifically directed.
- G. Provide continuous ground conductor or splice using connections qualified in accordance with IEEE 837.
- H. Provide waterstops on stranded, ground conductors where they enter a structure.

3.2 TES SUBSTATION GROUND GRID

- A. At the site for each TES substation, provide a ground grid as shown on Contract Drawings.
- B. Pre-test ground grid in accordance with Section 34 21 90, TES Testing, before pouring substation slab. If resistance is greater than 5 ohms, add additional ground rods until a resistance of 5 ohms or less is achieved.
- C. After delivery of each prefabricated substation, connect ground pigtailed from ground grid to substation-enclosure grounding pads at each of the four corners of the substation enclosure interior.
- D. Ground connections: Compression-type terminal lugs. Make connections in accordance with substation manufacturer's instructions.

3.3 RACEWAY GROUND

- A. Metallic and nonmetallic conduit: Provide a separate ground wire sized in accordance with NFPA 70, 250.122, Size of Equipment Grounding Conductors.

- B. Equipment grounds shall not be installed in a raceway with dc positive feeders or dc negative returns.

3.4 TES SUBSTATION INTERIOR PERIMETER GROUND BUS (BUILT-IN-PLACE SUBSTATION)

- A. Provide substation interior ground bus in built-in-place substation as specified above in Part 2 Article titled "Factory Assembly."
- B. Connect perimeter ground bus to building ground system.

3.5 FIELD TESTING

- A. Test grounds in accordance with Section 34 21 90, Traction Electrification System Testing.
- B. Grounds shall not exceed the following maximum resistance:
 - 1. TES substation enclosure or building ground: 5 ohms.
 - 2. Surge arrester grounds: 5 ohms.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

- A. The quantities of accepted work will be measured in the following units. All measurements will be plan measure except for authorized changes.
 - 1. Description: Lump Sum

4.2 PAYMENT

- A. Payment will be made at the respective unit or lump-sum price listed in the proposal and shall be full compensation for all labor, materials, and equipment necessary to complete the respective unit in place. There will be no separate measurement or payment for any item of work not specifically identified and listed in the proposal, and all such work shall be considered a subsidiary item with all costs pertaining thereto included in the prices for other items listed in the proposal. At the Engineer's option, partial payment may be made for any lump sum item listed in the proposal, providing that the Contractor is diligently and satisfactorily pursuing full completion of such partially complete item in accordance with the approved job progress schedule.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 34 22 29**TES RACEWAY AND EQUIPMENT HANGERS AND SUPPORTS****PART 1 - GENERAL****1.1 SUMMARY**

- A. This Section includes supports for raceway and equipment .

1.2 RELATED SECTIONS

- A. SECTION 34 21 06 – TES Common Work Results for Metals
B. SECTION 34 22 33 – TES Raceways and Boxes

1.3 REFERENCED STANDARDS

- A. Section incorporates by reference the latest revisions of the following documents:
B. ASTM International (ASTM)
1. ASTM A123/A123M, Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
2. ASTM F2329, Standard Specification for Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners

1.4 SUBMITTALS

- A. Procedures: Section 01 33 00, Submittal Procedures.
B. Product Data:
1. Submit for each type of specified material proposed for use.
2. Indicate the name of manufacturer, brand name, and catalog number for each type of material.

PART 2 - PRODUCTS**2.1 RACEWAY SUPPORTS**

- A. Conduit clamps for individual conduit supports: One-hole, galvanized, heavy-gage steel, or galvanized malleable iron with clamp back.
B. Channels, fittings and conduit racks: As specified in this Section.
C. Straps and clamps: Listed for the task.

2.2 METALLIC FRAMING CHANNEL AND FITTINGS

- A. Framing channel and channel fittings, clamps and accessories shall be hot-dip galvanized, or electro-galvanized and zinc chromate coated steel.

- B. Framing channel: 14-gage minimum, 13/16 inch or 1-5/8 inch-deep by minimum 1-5/8 inch-wide.
- C. Where heavy-duty racks are called out, framing channel shall be 12-gage, single or double 1-5/8 inch deep by 1-5/8 inch wide.
- D. Hanger rods: Galvanized steel or electro-galvanized and zinc chromate coated steel, 3/8-inch minimum.
- E. Prohibited: Aluminum, or light gage or strength metals or materials shall not be used.
- F. Acceptable Manufacturers:
 - 1. Unistrut;
 - 2. Powerstrut;
 - 3. Beeline; or approved equal.

2.3 NON-METALLIC FRAMING CHANNEL AND FITTINGS

- A. Framing channel and channel fittings: Heavy-duty vinyl ester fiberglass.
- B. Clamps, accessories, and hardware: Heavy-duty vinyl ester fiberglass or stainless steel.
- C. Acceptable Manufacturers:
 - 1. Unistrut;
 - 2. Powerstrut;
 - 3. Beeline; or approved equal.

2.4 ANCHORS

- A. Anchor Rating: Sufficient strength to support four times the load.
- B. For metal, use machine screws, bolts, or welded studs with nuts and lockwashers.
- C. Prohibited: Powder driven anchors or studs shall not be used.

2.5 FASTENERS AND HARDWARE

- A. Fasteners and hardware shall be suitable for the use and environment intended.
 - 1. Fasteners shall be corrosion resistant.
 - 2. Plated steel fasteners: Use only indoors, in dry locations.
 - 3. Prohibited: Unplated steel shall not be used.
- B. Stainless steel fasteners shall be used in splice boxes where exposed to weather, or in damp or wet locations.
- C. Bolted connections shall be made using lock washers.

2.6 CORROSION CONTROL

- A. Material and equipment shall be designed to ensure satisfactory operation and life in the environmental conditions that exist where the material or equipment is installed.

- B. Wherever "galvanized" or "hot-dip galvanized" is called out in this Section of the Specification, the material shall be coated in accordance with ASTM A123/A123M.
- C. For sheet steel, galvanized finish complying with Section 34 21 06, TES Common Work Results for Metals is an acceptable alternative to hot-dip galvanizing if cut edges are protected from corrosion.
- D. Galvanized Steel Field Coating: Organic cold galvanizing coating as specified in Section 34 21 06, TES Common Work Results for Metals.

2.7 FACTORY ASSEMBLY

- A. Conduit Supports and Racks:
 - 1. Load Rating: Conduit supports shall be capable of supporting a load equal to the sum of the weights of the conduit, wire, and the hanger itself, plus 200 pounds.
 - 2. Spare capacity: Minimum 25 percent.
 - 3. Multiple runs of exposed conduit: Group and support on conduit racks constructed from steel channels, conduit clamps and fittings.
 - 4. Vertical conduit racks: Provide supplementary bolted stop-blocks below each conduit clamp in a vertical strut to assure that clamps cannot slide down the channel.
 - 5. Multiple Conduits 2-inch or Larger: Support with heavy-duty channel, clamps and accessories.
 - 6. Individual Horizontal Conduits 2-inch or Larger: Support with individual hangers.
 - 7. Conduits 1-1/2 inch or smaller: Support with one-hole conduit straps with back spacers or individual conduit racks.
 - 8. Insulated: When conduit is within 18 inches above rectifier and dc switchgear, support with insulated materials.
 - 9. Make fittings up tight to prohibit movement, unless longitudinal movement is required due to conduit expansion.
- B. Cable Tray Supports:
 - 1. Support in accordance with Section 34 22 33, TES Raceways and Boxes, using steel channels, threaded rods and hardware.
 - 2. Insulate cable tray supports where cable tray runs over rectifiers and dc switchgear and supports are within 18 inches of rectifier or dc switchgear.
- C. Fasteners and Hardware:
 - 1. The material, coating and finish of fasteners and hardware shall be suitable for the environment and use intended.
 - 2. If fasteners or hardware exhibit corrosion, replace with a suitable type as directed by Engineer at no additional cost to the Owner.
- D. Damage Touch Up:
 - 1. Apply to galvanized surfaces where required due to cutting of hanger rods or channel, or construction damage.

2. Brush on a thick coat of cold galvanizing coating to cut ends. Coating may be sprayed on if at least three coats are applied.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Requirements of Article titled "Factory Assembly" apply to field installation.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

- A. The quantities of accepted work will be measured in the following units. All measurements will be plan measure except for authorized changes.
 1. Description: Lump Sum

4.2 PAYMENT

- A. Payment will be made at the respective unit or lump-sum price listed in the proposal and shall be full compensation for all labor, materials, and equipment necessary to complete the respective unit in place. There will be no separate measurement or payment for any item of work not specifically identified and listed in the proposal, and all such work shall be considered a subsidiary item with all costs pertaining thereto included in the prices for other items listed in the proposal. At the Engineer's option, partial payment may be made for any lump sum item listed in the proposal, providing that the Contractor is diligently and satisfactorily pursuing full completion of such partially complete item in accordance with the approved job progress schedule.

END OF SECTION

SECTION 34 22 33
TES RACEWAY AND BOXES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Electrical conduit and ducts
 - 2. Cable tray
 - 3. Outlet, junction, and pull boxes
 - 4. Electrical distribution cabinets

1.2 RELATED SECTIONS

- A. SECTION 34 21 05 – Common Work Results for TES
- B. SECTION 34 21 06 – TES Common Work Results for Metals
- C. SECTION 34 22 26 – TES Grounding and Bonding
- D. SECTION 34 22 29 – TES Raceway and Equipment Hangers and Supports
- E. SECTION 26 05 43 – Systemwide Electrical Underground Ductbanks and Raceways for Systems

1.3 DEFINITIONS

- A. Raceway: As defined in NFPA 70, and products specified in this Section.

1.4 REFERENCED STANDARDS

- A. Section incorporates by reference the latest revisions of the following documents:
- B. American National Standards Institute (ANSI)
 - 1. ANSI C80.1, Standard for Electrical Rigid Steel Conduit (ERSC)
- C. National Electrical Contractor's Association (NECA)
 - 1. NECA 1, Standard Practice of Good Workmanship in Electrical Contracting
- D. National Electrical Manufacturers Association (NEMA)
 - 1. NEMA 250, Enclosures for Electrical Equipment (1000 Volts Maximum)
 - 2. NEMA FG 1, Fiberglass Cable Tray Systems
 - 3. NEMA ICS 2, Industrial Control and Systems Controller, Contactors, and Overload Relays 600 V
 - 4. NEMA RN 1, Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit

5. NEMA TC 2, Electrical Polyvinyl Chloride (PVC) Conduit
 6. NEMA TC 3, Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing
 7. NEMA TC 14, Reinforced Thermosetting Resin Conduit (RTRC) and Fittings
- E. National Fire Protection Association (NFPA)
1. NFPA 70, National Electrical Code
 2. NFPA 130, Fixed Guideway Transit and Passenger Rail Systems
- F. Underwriters Laboratories (UL)
1. UL 2024, Signaling, Optical Fiber and Communications Raceways and Cable Routing Assemblies

1.5 SUBMITTALS

- A. Procedures: Section 01 33 00, Submittal Procedures.
- B. List of Materials:
1. Submit a list of materials proposed for use.
 2. Give name of manufacturer, brand name, and catalog number of each item.
 3. Submit list complete at one time, with items arranged and identified in numerical sequence by Specification Section and Article number.
- C. Compliance with Applicable Standards:
1. Where equipment or materials are specified to conform to standards of organizations such as ANSI, ASTM, and NEMA, submit evidence of conformance. The label or listing of specified agency will be acceptable evidence.
 2. Instead of the label or listing, Contractor may submit a written certificate from an approved, nationally recognized testing organization, stating that items have been tested and units conform to specified standard.
- D. Shop Drawings:
1. Submit shop drawings showing exact location and arrangement of conduits, cabinets, and pullboxes installed under this Contract.
 2. Submit drawings with ample time to prevent delays in Work.

1.6 QUALITY ASSURANCE

- A. Comply with the requirements of the Project Quality Plan.
- B. Qualifications: Raceway installers shall be electricians licensed by the State.

PART 2 - PRODUCTS**2.1 CONDUIT AND FITTINGS**

- A. Galvanized Rigid Steel (GRS) Conduit and Accessories: ANSI C80.1; hot-dip galvanized inside and out after threading; ensure each length bears UL label.
- B. GRS Fittings and Accessories:
 - 1. Bushings: Nylon-insulated, metallic.
 - 2. Grounding bushings: Nylon-insulated, metallic, with lay-in lugs.
 - 3. Sealing Bushings:
 - a. Galvanized malleable or ductile iron bushings with Bakelite sealing and pressure discs and individual neoprene cable rings.
 - b. Bushings shall seal ends of GRS conduit against the entrance of water, air or dust around emerging cables.
 - c. Approved Manufacturer/Product: O-Z/Gedney, type KR, or approved equal.
 - 4. Conduit straps, clamps, and clamp backs: Galvanized malleable iron.
 - 5. Vertical-Conduit Cable Supports:
 - a. Malleable or ductile iron body with hot-dip galvanized finish.
 - b. Non-metallic tapered wedging plug that supports cable without damaging insulation.
 - c. Weatherproof, ventilating type.
 - d. Acceptable Manufacturer/Product: O-Z/Gedney, type CMT, R-style, or approved equal.
- C. PVC-Coated GRS Conduit (PVC/GRS or PGRS): NEMA RN 1, with corrosion resistant internal coating.
- D. Reinforced Thermosetting Resin Conduit (RTRC): NEMA TC 14; standard or heavy-wall, UL listed.
 - 1. Conduit joints and fittings: Tapered or untapered; all of one type.
- E. PVC Electrical Conduit and Fittings:
 - 1. Conduit: NEMA TC 2, EPC-40-PVC or EPC-80-PVC; heavy wall, high impact strength, rigid PVC.
 - 2. Fittings: NEMA TC 3, EPC-40-PVC.
- F. Liquidtight Flexible Metallic Conduit and Fittings.
 - 1. Core: Flexible galvanized steel with a continuous copper bonding conductor spiral wound between the convolutions.

2. Jacket: Extruded liquid-tight plastic or neoprene; moisture- and oil-proof, capable of conforming to the minimum radius bends of flexible conduit without cracking; self-extinguishing with low halogen containing material.
3. Fittings: Zinc-coated.

2.2 OXIDE INHIBITING JOINT COMPOUNDS

- A. Petroleum-based compound with evenly suspended zinc particles.
- B. Approved Manufacturer/Product: Burndy, Penetrox A, or approved equal.

2.3 CABLE TRAY

- A. Type: Fiberglass, ladder or solid-bottom type with solid covers and other accessories, NEMA FG 1.
- B. Minimum Dimensions:
 1. Width: Minimum 6 inches.
 2. Loading depth: Minimum 3 inches.
 3. Inside nominal depth: Minimum 5 inches.
 4. Radius of curved fittings: Minimum 24 inches unless otherwise approved by Engineer.
- C. Performance Requirements:
 1. 30 inch width or less: Capable of supporting a total cable load of 55 pounds per linear foot on a maximum span of 8 feet, including a 200-pound static load as specified below.
 2. Over 30-inch width: Capable of supporting a total cable load of 88 pounds per linear foot on a maximum span of 8 feet including a 200-pound static load as specified below.
 3. Requirements shall be independent of type of splice plates or type of span, when tested in accordance with load test procedure specified in NEMA standards.
 4. Safety factor: 2, based on destructive load.
 5. 200 pound static load: Straight sections and fittings shall not permanently deform under a 200 pound static concentrated load applied vertically along a 4-inch length for both of the following conditions:
 - a. Load applied to center of one tray section having specified cable load and support spacing.
 - b. Load shall be applied at midpoint between supports over a splice connection.
 - c. Load applied to one rung of empty tray section having specified support spacing. Load shall be located at midpoint between side rails and supports.

2.4 CONDUIT HANGERS AND SUPPORTS

- A. Refer to Section 34 22 29, TES Raceway and Equipment Hangers and Supports.

2.5 OUTLET, JUNCTION, AND PULL BOXES

- A. Sheet metal outlet boxes: Steel, galvanized.
- B. Sheet metal junction and pull boxes: Galvanized or stainless steel, hinged or screw-cover with stainless steel screws.
- C. Cast metal boxes: Hot-dip galvanized inside and out.
1. Blank covers: Same thickness as boxes and secured with No. 10-24 stainless steel machine screws.
 2. Device covers: See Section 34 21 17, TES Substation Design and Installation.
 3. Neoprene gaskets: 1/8-inch thick.
- D. Nonmetallic boxes: Heavy duty, phenolic, surface-mounted, with threaded nonmetallic conduit hubs, type FD, single- or double-gang as required. Provide non-metallic device covers.
1. Acceptable Manufacturer/Product: Thomas & Betts, Carlon FSC-34, or approved equal.

2.6 ELECTRICAL CABINETS

- A. NEMA 1, 12, 4X, or as indicated.
- B. Galvanized or stainless steel, size as noted on Contract Drawings.
1. Fronts: Steel.
 2. Mounting: Surface or recessed type as required for the application.
 3. Hinges: Continuous, stainless steel.
 4. Locks: Provide flush locks from a single manufacturer with standard key blank; field-keyable.
 5. Finish: Powder coat, as specified in Section 34 21 06, TES Common Work Results for Metals.
 6. Cabinet back panel: white, galvanized steel interior mounting panel suitable for mounting terminal blocks and relays.
- C. Fiberglass composite:
1. Covers: Fiberglass.
 2. Hinges: Continuous, stainless steel.
 3. Surface: Smooth, no color variations, swirls, color pockets, or voids.

2.7 FACTORY ASSEMBLY

- A. See Part 3, below, for type requirements.
- B. Conduit:
 - 1. General:
 - a. Install electrical raceway, boxes and accessories in locations as indicated, in accordance with NFPA 70, NECA 1, local codes and ordinances, and as indicated to provide a complete and operable system.
 - b. Where a conduit type indicated on Contract Drawings is in conflict with this Section, refer discrepancy to Engineer.
 - 2. Conduit threading:
 - a. Clean threads with a solvent recommended by coating manufacturer to remove oil.
 - b. Coat threads with organic cold galvanizing coating, in accordance with manufacturer's instructions.
 - c. If spray application is used, provide at least three coats.
 - 3. Metal-to-metal threaded joints:
 - a. Coat threads with oxide inhibiting compound.
 - b. Take care that compound is not present on interior of conduit after installation.
 - 4. Conduit caps:
 - a. Provide threaded cap or similar closure designed for the purpose on conduits that are not terminated immediately.
 - b. Prohibited: Tape is not acceptable for temporary cap.
 - 5. Conduit sealing:
 - a. Conduit exposed to different temperatures: Seal conduit to prevent condensation and passage of air from one area to the other.
 - b. Where waterproofing is required, seal conduits with watertight duct sealing system.
 - 6. Liquid tight flexible metal conduit:
 - a. Install so that liquids tend to run off surface and do not drain toward fittings.
 - b. Provide sufficient slack to reduce the effects of vibration.
- C. Conduit Grounding and Bonding:
 - 1. Install metallic conduits to be electrically and mechanically continuous and connected to ground by bonding to the grounding system.
 - 2. See Section 34 22 26, TES Grounding and Bonding, for additional requirements.

- D. Conduit terminations:
1. Dry areas:
 - a. Provide two locknuts, one inside and one outside of box or enclosure, for rigid conduit terminating at steel box, panelboard, cabinet, or similar enclosure.
 - b. Provide insulating bushing or grounding bushing on conduit end.
 2. Exposed, damp and wet locations: Provide threaded, water-tight hubs with sealing o-rings for cabinet connections or threaded connections to tapered threaded hubs for cast boxes and fittings.
 3. Terminate the conduit in appropriate boxes at motors, switches, outlets, and junction points.
- E. Cable Tray:
1. General:
 - a. Install cable trays using approved fittings and adequately support the complete system. See Section 34 22 29, TES Raceway and Equipment Hangers and Supports.
 - b. Install cable trays parallel to each other and the building and plumb and level.
 - c. Support cable trays with wall brackets or ceiling-mounted supports from the prefabricated building structure, with anti-sway brackets or braces where necessary.
 - d. Trays shall be located no closer than 2-1/2 inches from the nearest wall, unless otherwise approved.
 2. Supports:
 - a. Finish: Hot-dip galvanized after fabrication.
 - b. Ceiling supports: See Section 34 22 29, TES Raceway and Equipment Hangers and Supports.
 - c. End supports: Support terminating sections of cable tray not more than 12 inches from end of tray.
 - d. Wall supports: Capable of sustaining an end-load of 1,600 pounds.
 - e. Spacing:
 - 1) Supports: Space at maximum distance of 5 feet to provide rigidity and adequate strength to support weight of trays and cables.
 - 2) Splices: Each tray splice shall have a support between 6 inches and 24 inches from the splice.
 3. Seismic bracing: Provide bracing for cable tray system complying with sealed seismic calculations required in Section 34 21 05, Common Work Results for TES.

-
4. Fasteners:
 - a. Solidly bolt trays to supporting channels using countersunk machine screws, 1/4 inch by 20 threads per inch, minimum.
 - b. After installation of fasteners, tray shall be free from burrs or sharp edges.
 5. Separators: Provide separators to isolate cables of different voltages.
- F. Boxes:
1. General:
 - a. Provide electrical boxes and cabinets of the material, finish, type, and size indicated and as required for the location, kind of service, number of wires, and function.
 - b. Ensure boxes and support fittings are of suitable and compatible materials that will not corrode when subjected to moisture or standing water.
 - c. Provide brackets, supports, hangers, fittings, bonding jumpers, and other installation accessories as required. Refer to Section 34 22 29, TES Raceway and Equipment Hangers and Supports.
 - d. Securely attach outlet, junction, and pull boxes to the structure. Do not use conduits entering the box as supports for the box.
 2. Covers:
 - a. Provide boxes complete with accessible covers designed for quick removal and suitable for the purpose for which they will be used.
 - b. Provide flat or raised blank covers for boxes without devices or fixtures.
 - c. Provide neoprene gaskets for boxes subjected to weather.
 3. Installation:
 - a. Mount outlet, junction, and pull boxes so as to prevent moisture from entering or accumulating within the boxes.
 - b. Junction and Pull Boxes: Install so that covers are readily accessible after completion of the installation.
 4. Grounding: Ground/bond each box and cabinet as specified in Section 34 22 26, TES Grounding and Bonding.
 5. Dc equipment: For areas within 6 feet of dc rectifier and dc circuit breaker enclosures provide nonmetallic pull-boxes, junction boxes, device boxes, and covers.

PART 3 - EXECUTION**3.1 RACEWAY TYPE REQUIREMENTS**

- A. Permitted Conduit Types:
1. Underground - General:
 - a. PVC/GRS conduit.
 - b. PVC Schedule 40 or standard-wall fiberglass conduit encased in concrete structures or ductbanks.
 - c. Heavy-wall fiberglass conduit.
 2. Underground - Exceptions:
 - a. KCP&L services: In accordance with KCP&L standards or as directed by KCP&L engineer.
 3. Transition between embedded conduit and above-ground metallic conduit: PVC/GRS.
 - a. Ensure that above-ground PVC/GRS extends minimum 1 foot above ground or to conduit termination, whichever is less.
 4. Conduits in TES substations:
 - a. GRS or RTRC.
 - b. Within 6 feet of dc rectifier or distribution breaker enclosures: RTRC.
 5. Liquid-tight flexible metal conduit:
 - a. Permitted only where required for flexibility such as connections to vibrating equipment and across joints subject to differential movement.
 - b. Not acceptable as a substitute for other conduit types in areas with complicated bending requirements.
 6. Conduit or raceway types not specifically called out in these Specifications or Contract Drawings shall not be used.
- B. Permitted Cable Tray Type: Fiberglass with insulating support hardware.
- C. Prohibited Raceway Types:
1. Wiring gutters or wireways.
 2. Electrical Metallic Tubing (EMT).
 3. Intermediate Metal Conduit (IMC).
 4. Flexible metal conduit.
 5. Conduit running thread.

3.2 RACEWAY MINIMUM SIZES:

- A. GRS: 3/4-inch.
- B. RTRC: 3/4-inch.
- C. Liquid-tight Flexible Metallic Conduit: 1/2-inch.

3.3 RACEWAY BENDS

- A. Minimum Bend Radius (above grade): In accordance with NFPA 70 Chapter 9 Table 2, "Other Bends" column.
- B. Refer to Section 26 05 43, Systemwide Electrical Underground Ductbanks and Raceways for Systems, for bending requirements for underground ducts.

3.4 BOX AND CABINET TYPE REQUIREMENTS

- A. Dry locations:
 - 1. Outlet boxes: Sheet metal outlet boxes.
 - 2. Junction or pull boxes with volume less than 100 inches: Sheet metal junction or pull box.
 - 3. Cabinets: Galvanized steel, NEMA 250 Type 1.
- B. Damp locations:
 - 1. Outlet, junction, and pull boxes: Cast metal boxes.
 - 2. Cabinets: NEMA 250 Type 4X stainless steel unless otherwise approved.
- C. Within 6 feet of dc switchgear:
 - 1. Cabinets: Fiberglass composite.

3.5 INSTALLATION

- A. Requirements of Article titled "Factory Assembly" apply to field installation.

PART 4 - MEASUREMENT AND PAYMENT**4.1 MEASUREMENT**

A. The quantities of accepted work will be measured in the following units. All measurements will be plan measure except for authorized changes.

1. Description: Lump Sum

4.2 PAYMENT

A. Payment will be made at the respective unit or lump-sum price listed in the proposal and shall be full compensation for all labor, materials, and equipment necessary to complete the respective unit in place. There will be no separate measurement or payment for any item of work not specifically identified and listed in the proposal, and all such work shall be considered a subsidiary item with all costs pertaining thereto included in the prices for other items listed in the proposal. At the Engineer's option, partial payment may be made for any lump sum item listed in the proposal, providing that the Contractor is diligently and satisfactorily pursuing full completion of such partially complete item in accordance with the approved job progress schedule.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 34 23 10**OCS DESCRIPTION AND GENERAL REQUIREMENTS****PART 1 - GENERAL****1.1 SUMMARY**

- A. The Traction Electrification Distribution System referred to hereafter as the Overhead Contact System (OCS) consists of all equipment needed to provide that part of the electrical circuit between the termination of the Traction Power Substation positive feeders at pole top or shop disconnect switches, and the contact wire interface with the vehicle pantograph, for the complete streetcar route, storage yard, and shop.
- B. For general Systems guidelines, refer to the Division 1 Specifications.
- C. Unless otherwise noted, the term "Owner" shall refer to the Kansas City Streetcar Authority throughout these Specifications.
- D. Unless otherwise noted, the term "Engineer" shall refer to the City Engineer or Owner's Designated Representative, as defined in General Provisions 3.1, City Engineer's Authority/Owner's Designated Representative.
- E. Unless otherwise noted, the term "Work" shall represent the entire scope of the construction of the Kansas City Streetcar project.
- F. The Contractor shall be responsible for coordinating all aspects of the Work, including but not limited to procurement, staging locations, traffic control, and all other tasks required to complete the Work.
- G. The route for revenue service is primarily double track along Main St. with a single track loop in the River Market area.
- H. Typically the selected streets have two way traffic operations, with the streetcar occupying two of the lanes, which is generally shared with vehicles travelling in the same direction.
- I. The storage yard and vehicle maintenance facility is located off the northeast corner of the River Market loop. It includes inbound and outbound tracks, storage tracks, and shop tracks, all of which are fully wired.
- J. Work under this contract includes the provision of OCS door attachment assemblies at the doors of the maintenance shop. The contractor shall coordinate the design of the selected attachment with the design of the building, taking full account of the form, fit, and function of the assembly and the selected door operating mechanism.
- K. Work under this Contract includes OCS design completion, materials procurement, installation, testing, and the provision of project records, operating and maintenance manuals, training, special tools, and spare parts in accordance with OCS Contract Drawings and Specifications.
- L. The OCS Contract Drawings and Specifications provide information regarding the Work and criteria for the Contractor to complete the OCS design, and install and test the Contractor's products. The Contractor shall provide all necessary engineering to ensure that the installed OCS meets the requirements of this Specification and referenced documents and drawings.

- M. The Contractor shall prepare a Contractor's OCS Design Completion Package (see Section 34 23 10 Part 2) with all information required for the OCS installation. The Contractor shall prepare designs that detail the use of the Contractor's products to achieve the required OCS installation.
- N. The equipment to be installed may include but is not limited to: poles, pole foundations, cantilevers, headspans, cross-spans, conductors, feeder jumpers, terminations, sectioning equipment, disconnect switches, surge arresters, contact wire bridges, and all other OCS associated components.
- O. The provision and installation of pole foundations are specified in the Missouri Department of Transportation Governing Specifications and Special Provisions.
- P. All OCS equipment is to be energized at a nominal 750 DC, and shall be double insulated.
- Q. All OCS Components shall be designed such that all fastenings and adjustments are accomplished with the same dimensional standards or tools. Metric standards or American standards (not both) shall be used throughout the OCS design.
- R. The Contractor shall coordinate with the Owner, Missouri DOT, and all other interested agencies regarding the Work.
- S. Double Insulation
1. A minimum of two levels of electrical insulation separated by a minimum dimension of four feet shall be provided between the contact wire and an OCS pole or other grounded structure.
 2. At support structures one level of insulation shall be at the contact wire supports, and the second level shall be adjacent to the structure. Physical locations of insulation shall be consistent with State of California Public Utilities Commission General Order No. 95, Section VII.
 3. At contact wire dead ends, two strain insulators shall be provided, separated by a minimum distance of 10 feet. Each level of insulation shall be rated to be compatible with the system insulation class.

1.2 RELATED SECTIONS

- A. Kansas City: streetcar project technical specifications (all volumes)
- B. Missouri Department of Transportation Governing Specifications and special provisions, as listed in Kansas City: Streetcar Project Technical Specifications
- C. DIVISION 01 – General Requirements
- D. SECTION 01 33 00 – Submittal Procedures
- E. SECTION 01 43 00 – Systems Quality Assurance
- F. SECTION 34 23 11.01 – OCS Glossary of Standard Terms
- G. SECTION 34 23 35.99 – OCS Pole Painting
- H. SECTION 34 23 37 – OCS Tubular Steel Poles
- I. SECTION 34 23 37.11 – OCS Pole Ornamentation
- J. SECTION 34 23 40 – OCS Wire and Cable
- K. SECTION 34 23 50 – OCS Assemblies, Components, and Fittings

- L. SECTION 34 23 64 – OCS Special Tools
- M. SECTION 34 23 66 – OCS Spare Parts
- N. SECTION 34 23 70 – OCS Installation
- O. SECTION 34 23 71 – OCS Pole Foundations
- P. SECTION 34 23 72 – OCS Tubular Pole Installation
- Q. SECTION 34 23 77 – OCS Surge Arrester Installation
- R. SECTION 34 23 78 – OCS Disconnect Switch Installation
- S. SECTION 34 23 80 – OCS Testing
- T. SECTION 34 23 90 – OCS Installation Records
- U. SECTION 34 23 96 – OCS Installation and Maintenance Manuals
- V. SECTION 34 23 97 – OCS Maintenance Staff Training
- W. Specifications for Street Lighting Attachments on OCS Poles shall be in accordance with Missouri Department of Transportation Governing Specifications and Special Provisions, in conjunction with Approval from the Engineer.
- X. Specifications for Traffic Signal Attachments on OCS Poles shall be in accordance with Missouri Department of Transportation Governing Specifications and Special Provisions, in conjunction with Approval from the Engineer.

1.3 REFERENCED STANDARDS

- A. The pertinent provisions of the latest revisions of the codes and standards of the applicable NEMA, IEEE, ASTM, AWS, NEC, and ANSI shall apply to the Work of this Section.
- B. If other types of materials are proposed, the Contractor shall, along with the product description, include the relevant standards and information on that material in his submittal.
 - 1. AISC S302 Code of Standard Practice for Steel Buildings and Bridges
 - 2. AISC S326 Design, Fabrication and Erection of Structural Steel
 - 3. ANSI C29.1 Test Methods for Electrical Power Insulators
 - 4. ANSI C29.2 For Insulators, Wet Process Porcelain and Toughened Glass Suspended type
 - 5. ANSI C29.7 Porcelain Insulators (High-Voltage Line-Post Type)
 - 6. ANSI C29.8 Apparatus, Cap and Pin Type (Wet Process Porcelain)
 - 7. ANSI C37.34 IEE Standard Test Code for High-Voltage Air Switches
 - 8. ANSI Z55.1 Gray Finishes for Industrial Apparatus and Equipment

9.	ASTM	A27/ A27M-10	Standard Specification for Steel Castings, Carbon For General Application
10.	ASTM	A36/ A36M-12	Standard Specification for Carbon Structural Steel
11.	ASTM	A47/ A47M-99	Standard Specification for Ferritic Malleable Iron Castings
12.	ASTM	A53/ A53M-12	Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, and Welded
13.	ASTM	A123/ A	123M-12 Zinc (Hot Dip Galvanized) coatings on Iron and Steel Products
14.	ASTM	A143/ A143M-07	Standard Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Steel Products and Procedure for Detecting Embrittlement
15.	ASTM	A153/ A153M-09	Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
16.	ASTM	A167-99	Standard Specification for Stainless and Heat-Resisting Chromium Nickel Steel Plate and Strip
17.	ASTM	A283/ A283M-12a	Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates
18.	ASTM	A307-12	Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 PSI Tensile Strength
19.	ASTM	A368-95a	Standard Specification for Stainless Wire Strand
20.	ASTM	A370-12a	Standard Test Methods and Definitions for Mechanical Testing of Steel Products
21.	ASTM	A384/ A384M-07	Standard for Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies
22.	ASTM	A475-03	Standard Specification for Zinc-Coated Steel Wire Strand
23.	ASTM	A484/ A484M-13	Standard Specification for General Requirements for Stainless Steel Bars, Billets, and Forgings
24.	ASTM	A492-95	Standard Specification for Stainless Steel Wire Rope
25.	ASTM	A493-09	Standard Specification for Stainless Steel Wire and Wire Rods for Cold Heading and Cold Forging-Bar and Wire
26.	ASTM	A518/ A518M-99	Standard Specification for Corrosion-Resistant High-Silicon Cast Iron
27.	ASTM	A530/ A530M-12	Standard Specification for General Requirements for Specialized Carbon and Alloy Steel Pipe

28.	ASTM	A536/ A536-84	Standard Specification for Ductile Iron Castings
29.	ASTM	A555/ A555M-05	Standard Specification for General Requirements for Stainless Steel Wire and Wire Rods
30.	ASTM	A563-07	Standard Specification for Carbon and Alloy Steel Nuts
31.	ASTM	A572/ A572M-12a	Standard Specification for High-Strength Low-Alloy Columbian-Vanadium Structural Steel
32.	ASTM	A588/ A588M-10	Standard Specification for High-Strength, Low Alloy Structural Steel, up to 50 KSI [345 MPa] Minimum Yield Point, With Atmospheric Corrosion Resistance
33.	ASTM	A595/ A595M-11	Standard Specification for Steel Tubes or High Strength Low Alloy, Low-Carbon, Tapered for Structural Use
34.	ASTM	A687-93	Standard Specification for High-Strength Nonheaded Steel Bolts and Studs
35.	ASTM	A668/ A668M-04	Standard Specification for Steel Forgings, Carbon, and Allow for General Industrial Use
36.	ASTM	A711/ A711M-07	Standard Specification for Steel Forging Stock
37.	ASTM	A747/ A747M-12	Standard Specification for Steel Castings, Stainless, Precipitation Hardening
38.	ASTM	B6-13	Standard Specification for Zinc
39.	ASTM	B8	Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
40.	ASTM	B26/ B26M-12	Standard Specification for Aluminum-Alloy Sand Castings
41.	ASTM	B33	Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes
42.	ASTM	B148-19	Standard Specification for Aluminum-Bronze Sand Castings
43.	ASTM	B172	Standard Specification for Rope-Lay-Stranded Copper Conductors Having Bunch-Stranded Members, for Electrical Conductors
44.	ASTM	B179-11	Standard Specification for Aluminum Alloys in Ingot and Molten Form for Castings From All Castings and Processes
45.	ASTM	B187/ B187M-11	Standard Specification for Copper, Bus Bar, Rod and Shapes and General Purpose Rod, Bar and Shapes

46.	ASTM	B248-12	Standard Specification for General Requirements for Wrought Copper and Copper-Alloy Plate, Sheet, Strips and Rolled Bar
47.	ASTM	B249/ B249M-12	Standard Specification for General Requirements for Wrought Copper and Copper-Alloy Rod, Bar and Shapes and Forgings
48.	ASTM	A580-79	Standard Specification for Stainless Steel Wire
49.	ASTM	B584-79	Standard Specification for Copper Alloy Sand Castings for General Applications
50.	ASTM	C150/ C150M-12	Standard Specification for Portland Cement
51.	ASTM	C151/ C151M-09	Standard Test Method for Autoclave Expansion of Hydraulic Cement
52.	ASTM	D116-86	Standard Test Method for Vitrified Ceramic Materials for Electrical Applications
53.	ASTM	E709-08	Standard Guide for Magnetic Particle Testing
54.	ASTM	F436-11	Standard Specification for Hardened Steel Washers
55.	ASTM	F593-02	Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs
56.	ASTM	F1554-07ae1	Anchor Bolts, Steel, 36, 55, and 105 KSI Yield Strength
57.	AWS	D1.1	Structural Welding Code, Steel
58.	NEMA	HV 2	Application Guide for Ceramic Suspension Insulators
59.	NFPA	(NEC)	Current Edition
60.	GO95	CA PUC	State of California Public Utilities Commission General Order No. 95, current edition.

1.4 SUBMITTALS

- A. Submittals shall be in accordance with the requirements of SECTION 01 33 00 – Submittal Procedures, except as modified herein.
- B. Submit a Contractor's OCS Detailed Design Completion Package as listed below and defined in SECTION 34 23 10 Part 2.
- C. General Design Information Submittals containing:
 1. Shop drawings
 2. Framing attachment height and dimension methodology and sample calculations
 3. Pole rake methodology and sample calculations
 4. OCS wire schedules
 5. Bills of materials

1.5 QUALITY ASSURANCE/QUALITY CONTROL

- A. Quality Control/Quality Assurance shall be in accordance with SECTION 01 43 00 – Systems Quality Assurance except where modified within this Specification Section.

1.6 OVERHEAD CONTACT SYSTEM STYLES

- A. Single Contact Wire Fixed Terminated Style
1. The wiring shall be supported and registered by means of cantilevers, or various styles of head span assemblies. At sharp curves and corners, wire pulloff or steady span assemblies may be used for registration. The contact wire shall be staggered.
 2. Wire terminations shall be fixed at both ends, each with capability for maintenance adjustment.

1.7 OCS POLES

- A. Tubular Poles
1. There will be 5 general configurations of OCS poles on the project; sole use OCS poles, OCS poles with street lighting, OCS feeder poles, Ornamental OCS poles, and OCS poles with traffic signal accessories. In some cases there will be combinations of these configurations. OCS pole finish may vary on the project, possibly utilizing both galvanized and painted finishes. The Contractor shall verify OCS pole types and finishes with the Engineer prior to procurement. See SECTIONS 34 23 37 – OCS Tubular Steel Poles, 34 23 37.11 – OCS Pole Ornamentation, 34 23 35.99 – OCS Pole Painting, and the Missouri Department of Transportation Governing Specifications and Special Provisions for related Specifications. OCS poles shall be procured based on these Specifications and Contract Drawings, in conjunction with Approval from the Engineer.

1.8 OCS TERMINATION WIRE ATTACHMENTS TO BUILDINGS

- A. OCS anchors will be required at the maintenance facility to reduce the tension in the shop contact wire, as well as to terminate the contact wire inside the building. The installation of this connection shall be subject to Inspection and Approval by the Engineer. After the attachment is approved by the Engineer, the Contractor shall be permitted to install and terminate the contact wire. Refer to the Contract Drawings (OCS Drawings and Vehicle Maintenance Facility Structural Drawings) for building attachment locations, anchor bolt details, and contact wire tension information.

1.9 OCS CONTRACT DRAWINGS

- A. OCS Basic Design Contract Drawings are standard drawings showing typical OCS design features for use at site-specific locations as detailed in OCS Wiring Layouts and Schedules.
1. General Drawings: General Drawings provide standard OCS abbreviations, drawing symbology, general electrical clearance data, and sample OCS plan and schedule drawings.
 2. Technical Sheets: The Technical Sheets provide information regarding design data, parameters, conductor characteristics, conductor tensions, temperature conditions, maximum wiring spans on tangent and curved track, wind blow off data, maximum mid span offset, pantograph security, and pantograph clearance.
 3. General Arrangement Drawings: General Arrangement Drawings show the layout and dimensions for poles and wiring at overlaps, crossovers, and terminations.

4. Typical Structure Drawings: Typical Structure Drawings provide typical arrangement views for various common functions of OCS structures. These drawings provide required dimensions, and identify assembly drawings showing typical equipment suitable for the structure's function.
5. Assembly Drawings: Assembly Drawings are pre-shop drawings which show the arrangement of several generic components assembled as cantilevers, headspans, cross-spans, pull-offs, and other OCS equipment.
6. OCS Layout Drawings:
 - a. The OCS Layout Drawings show structures and OCS wiring. Tables for each track indicate structure number, contact wire height, conductor termination heights, contact wire stagger and direction, and pole types. Additional information includes span lengths, location of section insulators, disconnect switches, jumpers and feeders, backbone/pull off arrangements, and other relevant information.
 - b. Electronic copies of the OCS Layout Drawings in the Contract Drawings will be made available to the Contractor within 30 days of Notice To Proceed.
7. Foundation Schedules: Foundation Schedules are tables that include stationing, grounding types, and measurements to accurately locate and install the OCS foundations.
8. Master Overlap Charts: Provides information regarding OCS tension lengths, pertinent road crossings, passenger stations, and other general information in the scope of installation.

1.10 AMBIENT AND CONDUCTOR TEMPERATURES

- A. The normal conductor temperature for computing erection conditions is 60 degrees Fahrenheit. The maximum conductor temperature is 120 degrees Fahrenheit. The minimum conductor temperature is minus 20 degrees Fahrenheit.

1.11 ICE LOADING

- A. For structural design calculations, a radial thickness of 1/2 inch ice on the contact wire shall be used. A radial thickness of 1/2 inch shall be used on all solid-type structures and structural members (pole brackets, cantilevers, etc.).

1.12 WIND LOADING

- A. A maximum wind speed of 90 mph or maximum wind speed given by local codes shall be applied to poles and rigidly attached brackets.
- B. A maximum wind speed of 55 mph shall be used when there is radial ice.
- C. Maximum windspeed for streetcar operations is 40 mph, applied to conductors with no ice loading.

1.13 LEVELS AND PLACEMENT OF INSULATION

- A. A minimum of two levels of electrical insulation shall be provided. Each level of insulation shall be rated to be compatible with the system insulation class.
- B. The first level of insulation shall be installed at the contact wire support.

- C. Physical locations of insulation shall be as shown in the Contract Drawings, and in conjunction with GO-95. At contact wire dead ends, two strain insulators shall be provided, separated by a minimum distance of 10 feet. The first level of insulation shall be installed so as to be 4 feet minimum and 5 feet maximum horizontally from superelevated track centerline.

1.14 CONTACT WIRE HEIGHTS

- A. The normal contact wire height at supports shall be 19 feet 6 inches.
- B. Minimum contact wire heights in streets or road crossings shall be 18 feet 0 inches after allowance for conductor sags due to temperature variations, ice loading, and conductor installation tolerances. The heights shall take into account the tolerances for track maintenance and construction.
- C. Minimum contact wire height under bridges shall be 15'-4".
- D. Clearances between the OCS and various overhead utilities shall be in accordance with the National Electrical Safety Code, and these Contract Drawings and Specifications.

1.15 CONTACT WIRE GRADIENTS

- A. The maximum rate at which the contact wire shall change its elevation relative to the track elevation shall be as follows:

Constant Gradient	2%
Gradient Change	1%

- B. The maximum line speed limit shall be 35 mph for OCS purposes.

1.16 PANTOGRAPH SECURITY

- A. The minimum allowable pantograph security shall be 6 inches.

1.17 CONTACT WIRE RADIAL LOADS

- A. The contact wire deviation at any single contact wire swivel clamp shall not exceed 7 degrees.
- B. Under maximum non-operating conditions where the contact wire registration loads exceed 850 lbs, two steady arms shall be used.
- C. Steady arm shape and heel settings shall be designed and installed in accordance with Contract Drawings.
- D. The heel point of the steady arm shall be outside of the limits of the pantograph envelope under both static and uplifted conditions.

1.18 FACTORS OF SAFETY

- A. The OCS shall be designed with the following minimum factors of safety under the temperature, wind, and ice loadings specified:

Equipment	Minimum Safety Factor
Conductors:	
Operating	2.0
Non-Operating	1.6

Hardware, assemblies, fittings, components, and non-electrical wires:

Operating against breakage	2.5
Operating against slippage	2.5
Non-Operating against breakage	2.0
Non-Operating against slippage	2.0

Structures designed per AISC (LRFD or ASD)

- B. The permitted wear of the contact wire shall be 30% of its original cross-sectional area. The safety factors stated above shall apply to the contact wire when worn.

1.19 PANTOGRAPH CLEARANCE ENVELOPE

- A. The installed OCS, including the steady arm in the uplifted position, shall not intrude into the pantograph clearance envelope for the applicable contact wire height. For the pantograph envelope and related clearance requirements under various conditions, see OCS Technical Sheets.
- B. For test purposes, the contact wire shall be lifted with the test pantograph by 3 inches from the free hanging condition, to verify clearance with uplift. In addition, 0.5 inches of pantograph carbon wear will be allowed from a new carbon outline on the test pantograph.

1.20 ELECTRICAL CLEARANCES

- A. The following electrical clearances shall be maintained:

1. Normal Minimum Static	6 inches
2. Normal Minimum Passing	4 inches
3. Absolute Minimum Static	5 Inches
4. Absolute Minimum Passing	3 inches
- B. All erected poles, brackets, switch operating handles, and other Contractor-installed equipment shall comply with the electrical clearances given in the OCS Drawings.
- C. Minimum electrical clearances shall apply after all applicable design allowances and construction tolerances have been accounted for.
- D. Refer to SECTION 34 23 11.01 – OCS Glossary of Standard Terms for definitions of static and passing conditions.

1.21 MECHANICAL CLEARANCES

- A. All erected poles, brackets, switch operating handles and other Contractor-installed equipment shall comply with the Streetcar clearance requirements of the current issue of the Design Criteria document.

1.22 TOLERANCES

- A. Unless otherwise specified in the Missouri Department of Transportation Governing Specifications and Special Provisions, pole foundations constructed shall have the following dimensional erection tolerances applied relative to the Contract Drawings:

1. Foundation offset from track centerline:	2 inches
2. Stationing along track Centerline adjacent to special trackwork:	2 feet

3. Stationing along track centerline at street intersections: 1 foot
4. Stationing along track centerline on open track: 5 feet
5. Span length change between adjacent pole foundations 5 feet

1.23 RETURN CIRCUIT

- A. See Traction Power Specifications for Return Circuit information.

PART 2 - PRODUCTS

2.1 CONTRACTORS OCS DESIGN COMPLETION PACKAGE

- A. Electronic copies of the OCS Drawings in the Contract Drawings will be provided to the Contractor.
- B. The Contractor's OCS Design Completion Package shall consist of the following:
 1. Shop Drawings.
 - a. Shop drawings for each OCS Assembly shall be produced and submitted for approval. Each Assembly drawing shall show the arrangement of OCS fittings and the pantograph clearance envelope for the designed contact wire height where applicable. Drawings shall also show minimum track offset, superelevation, and any other pertinent information where the assemblies will be installed.
 - b. Shop drawings relating to Cantilever Assemblies shall include the following:
 - 1) All cantilevers shall have double insulation. One level shall be at the conductors, and one level at the connection to the pole brackets.
 - 2) The reach of any cantilever shall not be more than three times the dimension between its support brackets on the pole, unless verified through calculation or modeling to verify structural adequacy.
 - 3) Drop-tube of cantilevers shall be checked during cantilever design to ensure minimum 1 inch running clearance to the pantograph clearance envelope.
 - c. Shop drawings relating to headspan, cross-span, or pull-off assemblies shall include the following:
 - 1) All headspans, cross-spans, and pull-off assemblies shall be double insulated.
 - 2) Cross-span insulation shall be provided in headspan wires, cross-span wires, span guys, and pull-offs in accordance with the requirements as shown in the Contract Drawings and Specifications.
 - 3) Headspans shall be designed with geometry as shown on the Contract Drawings.
 - 4) The minimum headspan attachment height at a pole shall be calculated based on the site specific headspan geometry.

- 5) Attachment heights for the (upper) headspan wires shall be a minimum of 6 inches below the tops of poles, or, where relevant, streetlight attachment points.
 - 6) Pull off assemblies shall only be used where total radial loadings on the steady arm at the opposite end of the assembly from the support exceed 200 lb at any temperature or wind condition. Where this condition cannot be met, steady span (double ended pull-off) assemblies shall be installed.
 - 7) Wiring dimensions for all head span, cross-span, pull-off and backbone assemblies.
- d. Shop drawings of assemblies and products shall be produced such that they demonstrate that the required OCS functions and configurations are achieved.
 - e. Each shop drawing shall be given an Assembly Reference that shall match the equivalent Contract Assembly Drawing and shall carry the same title.
 - f. Each shop drawing shall have a bill of materials listing all components, and include their part or catalog number, descriptive text, quantity required, and unit of measure.
 - g. Each shop drawing shall show details of all components including electrical characteristics, materials, dimensions, load ratings, and weights.
 - 1) Shop drawings for any single site specific assemblies or components that are not included in the Contract Drawings. Site measurement records, and design calculations for any such sites shall also be submitted.
 - 2) Calculation and documentation of cantilever, headspan, cross-span, pull off, and backbone assemblies shall provide loads, geometry, maximum and minimum dimensional limits, and application rules. This documentation shall be produced for the maximum loadings for each type of assembly.
 - 3) Methodology and calculations used to determine pole rake and orientation shall be submitted.
 - 4) OCS wire schedules shall be produced for all conductors to be installed.
 - 5) Projectwide Bill of Materials identifying all OCS components and component quantities used in the OCS installation shall be submitted. The Contractor shall furnish this information in tables as described below:
 - a) OCS components listed in alphabetical order.
 - b) OCS components listed in order of catalog number.
 - 6) Contractor's OCS Layout Plan design update drawings shall show the final installation including:
 - a) Assembly references for cantilevers, headspans, pull-offs and registration types attached to each structure.
 - b) Pole rake values and orientation dimensions.

- c) Design changes due to Contractor's equipment selection.
- d) Design changes affecting material selection and/or OCS structure location or offset.

2.2 DRAFTING STANDARDS

- A. The Contractor's Drawings submitted in electronic form should be drafted in accordance with Drafting Standards approved by the Engineer.

PART 3 - EXECUTION

3.1 DESCRIPTION OF WORK

The Contractor shall design, furnish, and install the OCS for the Project as described and referenced in the following.

- A. Perform Design Completion, as described in these Specifications, including but not limited to the following.
 - 1. Performing and submitting calculations to verify assembly and component adequacy.
 - 2. Producing and submitting shop drawings of all assemblies and components.
 - 3. Producing assembly and component test reports and certificates of compliance as described in these Specifications.
 - 4. Producing and submitting installation plans, test plans, and all other pertinent OCS design and installation documentation as described in these Specifications.
- B. Supply and install OCS conductors, OCS poles, OCS foundations, cantilevers, cross-spans, headspans, pull-offs, section insulators, any special pole or wiring anchors, and all other OCS components in accordance with the Contract Drawings and these Specifications.
- C. Perform and submit the required OCS system testing and documentation as required in these Specifications.
- D. Perform as-built measurements and drawing updates to be submitted as required in these Specifications.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

- A. The quantities of accepted work will be measured in the following units. All measurements will be plan measure except for authorized changes.
 - 1. Description: Lump Sum

4.2 PAYMENT

- A. Payment will be made at the respective unit or lump-sum price listed in the proposal and shall be full compensation for all labor, materials, and equipment necessary to complete the respective unit in place. There will be no separate measurement or payment for any item of work not specifically identified and listed in the proposal, and all such work shall be considered a subsidiary item with all costs pertaining thereto included in the prices for other items listed in the proposal. At the Engineer's option, partial payment may be made for any lump sum item listed in the proposal, providing that the Contractor is diligently and satisfactorily pursuing full completion of such partially complete item in accordance with the approved job progress schedule.

END OF SECTION

SECTION 34 23 11.01**OCS GLOSSARY OF STANDARD TERMS****PART 1 - GENERAL****1.1 SUMMARY**

- A. This Section contains a glossary of Overhead Contact System (OCS) terms that define words and terms used in the Contract OCS Drawings and Specifications. The Systems Contractor shall ensure that supplied shop drawings, Test Certificates, OCS records and other OCS documentation required by the OCS Specifications use the preferred terms given in this Specification.

1.2 RELATED DOCUMENTS

- A. For general electrical terms, see "IEEE Standard Dictionary of Electrical and Electronic Terms", IEEE Standard 100 - Latest Edition
- B. For insulated cables, the definitions of terms shall be in strict accordance with applicable publications of ICEA for the cable provided.

1.3 GLOSSARY OF TERMS FOR OVERHEAD CONTACT SYSTEMS

- A. The purpose of this glossary is to provide uniform terminology and definitions for technical terms used in design of the Overhead Contact System. These terms will form the basis for assembly descriptions used in material allocation and control. The glossary does not include standard transit and electrical engineering terms, but is intended to define terms for which industry standard definitions have not been universally adopted, especially those related to Overhead Contact Systems.

Terms marked with an asterisk (*) are not preferred. Use preferred terms.	
Anchor –	
anchor bolt	A bolt inserted into a concrete foundation to form an attachment for a pole or support bracket.
Anchor base pole*	See "bolted-base pole".
Arrangement Drawing (OCS)	A group of structures in a specific configuration providing the wiring of a typical short section of OCS; e.g., overlap, crossover.
Assembly Drawing (OCS)	A configuration of components used repetitively in the OCS, and identified in combination as a group for ease of reference.
Assembly Reference	An alpha numeric code assigned to a discrete group of components of discrete design and discrete number that comprise a discrete assembly.
AWG	American Wire Gauge
Backbone	A span guy or wire between structural supports used primarily to register contact wires around a curve by means of a set of registrations attached along the backbone.
Backguy*	See "Guy".
BIL	Basic Impulse Level
Blow-off	Lateral displacement of the contact wire due to wind.
Body span wire	The center span wire of a three-wire Headspan.

Terms marked with an asterisk (*) are not preferred. Use preferred terms.	
Bolted – base pole	A pole for use on a foundation with anchor bolts (as opposed to plain pole which is embedded in earth or concrete).
Bond –	An electrical connection between metal hardware to eliminate voltage difference.
impedance bond	An inductive device bridging an insulated rail joint used for allowing passage of DC traction return current while preventing passage of high-frequency current used for signaling.
rail bond	Electrical connection between adjacent lengths of rail.
structure bond	An electrical connection between structure and rail or impedance bond.
Bracket or gain*	A connection to a pole by means of which the cantilever or bracket arm assembly is attached to the pole.
Bracket arm or Mast arm*	The frame assembly supporting a direct suspension single contact wire system from a pole (A bracket arm which is hinged to pole has the preferred term “cantilever”).
Bridge*	See “Overpass” or “Underpass”.
Break*	See “Section break”.
Bridle	A span guy or wire between structural supports used primarily to provide vertical support to a cross-span wire attached approximately midway along the bridle.
Bull ring	A steel ring usually 2-4 inches in diameter into which two or more span guys are connected.
Bypass switch	A disconnect switch at a non-feeder sectionalization point in the OCS.
Cable outlet	A short pipe installed through the wall of a tubular pole, through which a feeder cable exits the pole.
Carbon collector*	See “contact strip”.
Cantilever	The support frame and registration assembly supporting the catenary from a pole, and attached to the pole via hinge fittings.
Catenary –	The combination of conductors, hangers and in-span hardware of the overhead contact system used in LRT operation, not including supports and cantilevers.
dictionary meaning	The curve assumed by a perfectly flexible weighted cord of uniform density and cross-section hanging freely between two fixed points.
simple catenary	Comprising a contact wire supported from a messenger wire by hangers.
compound catenary	Comprising a contact wire, an auxiliary wire and a messenger wire, with associated hangers.
stitched catenary	A catenary system to which a stitch wire has been added at the supports to improve catenary dynamics.
tramway equipment* or single contact wire	Comprising a contact wire only.
Chording of curves	On curved route the propensity of the contact wire to “cut the curve” between registrations.

Terms marked with an asterisk (*) are not preferred. Use preferred terms.	
Circular mil	One thousandth part the area of a circle one inch in diameter.
Clamp –	
contact swivel clamp	The fitting on the end of the steady arm or registration pipe which attaches to the contact wire.
parallel groove clamp	A piece of hardware used to clamp two parallel wires together.
pipe clamp	A piece of hardware used to attach various types of components to a pipe.
strain clamp	A piece of hardware used for deadending a wire or conductor under high mechanical tension.
suspension clamp	A piece of hardware used to support a tensioned conductor or cable in a hanging arrangement, the greater part of the applied load being due to gravity.
Clipping in	The process of sagging an overhead wire to correct tension and clamping it at the support and fixing the hangers.
Commutation	The act of picking up electrical power from an overhead contact wire by pantograph.
Component	An item of hardware as commonly supplied complete by a manufacturer.
Contact bridge	A rigid bar, fixed closely above and attached to the in-running contact wire forming a slot for a second contact wire to pass through, thereby preventing differential uplift of crossing contact wires. Also called a “wire cross”.
Contact Strip	The replaceable wearing part of the pantograph collector head assembly which interfaces with the overhead contact wire for collecting current.
Contact wire or Trolley Wire*	The wire of an OCS with which the pantograph of a Streetcar makes contact for current collection. Normally made of copper or bronze, the wire is a single conductor with a groove to which hangers and clamps may be fitted.
Contact wire height –	The height of the underside of the contact wire above rail level when not uplifted by the pantograph.
minimum contact wire height	The minimum allowable contact wire height, usually at midspan or under bridges, which takes due account of vehicle clearance envelope, vehicle bounce and track tolerances, catenary temperature effects and electrical clearances. May also take future track raising into account if so required.
maximum contact wire height	The maximum allowable contact wire height within the operating range of the vehicle current collector.
Copperweld conductor	A wire with a steel center and a layer of copper fused around it or a number of such wires stranded together.
CR	Conduit Riser
Creep	The on-going permanent stretch of copper wires under mechanical tension for long periods of time.
Crossarm*	See “Cantilever”, “bracket arm”.
Cross level	The plane through the tops of the rails of a track in the transverse direction.
Cross level tolerance	See “Track tolerances”.

Terms marked with an asterisk (*) are not preferred. Use preferred terms.	
Cross-span	An installation of wires that crosses the track or roadway at approximately contact wire level; more specifically a single or double wire fastened to poles on either side of the route and supporting one or more contact wire(s).
Current collector	The rubbing strip at the top of a pantograph which rides along under the contact wire.
Curve Supports –	
inside curve	An arrangement for an OCS where the poles are on the inside of the curve, relative to the track.
outside curve	Poles are on the outside of the curve, relative to the track.
CW	Contact Wire
DGA	Down Guy Assembly
Direct Suspension Overhead Trolley Contact System	Wherein the trolley contact wire is attached by suitable devices directly to the main supporting system.
Double insulation	Insulation function provided by two physically separated insulators, installed at a nominal minimum and maximum spacing.
Droop	Fall of a conductor from its position at normal temperature, due to temperature change and/or ice coating.
Dropper*	See “Hanger”.
Drop bracket	An assembly fixed to the underside of a registration pipe that carries the steady arm.
DSW	Disconnect Switch
Dynamics or catenary dynamics	The interactive relationship between pantographs and contact wires at operating speeds; commutation performance.
Elastic system	A term applied to an overhead system where the contact wires are free to uplift under the pressure of the current collectors at the supports. Usually pendulums comprising one hanger or two articulating parallel hangers.
Electrical clearance –	
passing	The dimensional mechanical clearance between live part of either the vehicle (such as uplifted pantograph) or catenary and grounded parts of the fixed structures, due to the dynamics of the passage of a moving or stationary vehicle. See AREMA Standards Chapter 33.
static	The dimensional mechanical clearance between live parts of the OCS and grounded parts of fixed structures, in the absence of pantographs.
Embedded poles	Poles without base plates, directly inserted into socket-type or open foundations and fixed by grout or compacted backfill such as sand.
Encumbrance*	See “pole encumbrance” and “system height”
Envelope –	
vehicle static envelope	The maximum envelope of a static vehicle
vehicle dynamic envelope	The maximum envelope of a moving vehicle when it is free to lurch and sway.

Terms marked with an asterisk (*) are not preferred. Use preferred terms.	
combined vehicle envelope	The vehicle dynamic envelope plus the effects of maximum track alignment and cross-level tolerances.
structure clearance envelope	The combined vehicle envelope plus a safety clearance allowance typically 6 inches all round.
pantograph clearance envelope	The combined clearance envelope of the pantograph plus a lateral allowance for safety and vertical allowance above static contact wire level. Only steady arms and registration arms are permitted within this envelope.
Equation*	See Station Equation.
Equivalent span or ruling span*	A mathematically weighted average span of a given tension length of conductors used in sag-tension calculations.
Exclusive right-of-way	Right-of-way only accessible to Owner's own vehicles and maintenance personnel.
Eye bolt	A bolt embedded in the face of a building or other structure with an "eye" or "ring" at the exposed end, for attachment of span guys.
Face of pole	The absolute nearest part of a pole from the track but excluding the base plate unless this is located significantly above the level of the rails and intrudes into the clearance envelope.
Facing turnout	A track turnout oriented to be directly entered in the normal direction of travel (see also Trailing turnout).
Feeders	Conductors which supply power to or augment the power-carrying capacity of the conductors in an overhead contact system.
Feeder spout* or feeder outlet*	See "Cable Outlet".
Finial*	See "Pole Cap".
Fittings	Small components used in assembly of cantilever pipes and catenaries
Fixed-terminated (FT) equipment	OCS with dead-ended conductors at both ends.
FTA	Fixed Termination Anchor
Frog (Track)	A rail component used at the intersection of two running rails to provide support for wheels and passages for their flanges, thus permitting wheels on either rail to cross the other.
Gain*	See "bracket".
Galv.	Galvanized
Gauge –	
load gauge	The envelope around the track within which all loaded track vehicles are specified to remain while static or in motion.
track gauge	The distance between the inside running edges of the track.
electrical umbrella*	The electrical clearance envelope for the pantograph in the swayed position over its operating height range. See also "pantograph clearance envelope".
pole gauge	The thickness of steel in a tubular pole.

Terms marked with an asterisk (*) are not preferred. Use preferred terms.	
Grade crossing	A crossing of a highway, railroad track, other fixed guideway, or pedestrian walk or combination of these at the same level.
Grade separation	A vertically separated crossing of a highway or walkway from a rail track by the provision of a bridge or underpass.
Gradient (contact wire)	The average slope of the contact wire between two adjacent catenary supports measured relative to the track.
Ground wire	The conductor installed for the purpose of providing electrical continuity between the supporting structure of the overhead contact system and the common return or grounding system.
GRS	Galvanized Rigid Steel
Guy –	A steadying or positioning wire.
down guy or back guy*	A wire attached high on a pole and coming down at an angle to an anchor in the ground.
head guy or span guy	A wire between two points but not anchored to ground.
sidewalk down guy	A down guy which is diverted to a vertical position for anchorage to the ground, by use of a horizontal strut braced against the pole at a high level. Used where the normal down guy anchorage would obstruct a sidewalk or other pathway.
guard	A (yellow) plastic strip which fits around the lower end of a down guy for increased visibility. Required to extend 8 feet minimum above ground.
HD	Hard Drawn
Hand hole	An access hole in a pole for cable installation or inspection.
Hanger	A wire assembly by means of which the contact wire is suspended from the messenger wire at regular intervals (typically every 15-30 feet).
Headspan	An installation of two or more wires that crosses the tracks and supports a simple catenaries, or several single contact wires in multi-track area.
Heel of steady arm	The pivoted end of a steady arm opposite to the end with the contact wire clamp.
Heel Setting	The dimensioned height of the pin at the heel of a steady arm or registration pipe above the plane of the contact wire.
Horns	The curved or angled downwards ends of the pantograph head which ensure movement of out-of-running wires onto the contact strip.
ID	Identification or Internal Diameter
I&M	Installation and Maintenance
Impedance bond	See “bond”.
In-running catenary	The catenary in multiple catenary sections (such as overlaps) providing the passage for the pantograph.
Insulator –	Any body or substance provided and designed for the purpose of surrounding, supporting or interrupting an electrical conductor so as to restrict the flow of electricity to a desired path.
bell or disc	A bell shaped insulator of glass or porcelain used singly or in strings.
Johnny ball*	A type of strain insulator used primarily for guy or span wire insulation.

Terms marked with an asterisk (*) are not preferred. Use preferred terms.	
no-bo	The brand name for a type of section insulator without skirts.
section	See "section insulator".
standoff	A solid core insulator with bending strength.
strain	An insulator or a string of disc insulators used in line with a tensioned conductor.
strut	A standoff insulator used in compression members of cantilevers.
suspension	An insulator or string of disc insulators which are suspended in vertical position.
synthetic	An insulator made from fiberglass, plastic or epoxy resin.
Insert	A mechanical screw socket-type fixing for direct embedment into concrete usually placed before concreting.
Insulated overlap	A sectionalization point in an OCS formed by cutting insulation into the out-of-running sections of the two overlapping catenaries.
Jumper –	Generally an internal electrical connection in the overhead contact system; a short conductor assembly installed to provide electrical continuity.
continuity or full current	A jumper capable of carrying full line current from one catenary to another longitudinally at tensioning overlaps and track turnouts.
equalizing	A light internal jumper in the OCS, connecting the messenger to the contact wire for electrical continuity. Generally once in each span.
kcmil	One thousand circular mils
LF	Linear foot/feet
LS	Lump sum
Lightning Arrester*	See "Surge Arrester".
Line guard	A bunch of short (12 inch) wires with preformed twist that self lock around a conductor and used to prevent abrasion of the conductor.
Live –	
live load (structural)	A load or force that is temporary in nature such as wind, ice, and the dynamic uplift force of a passing pantograph.
live wire (electrical)	A conductor carrying a voltage for power supply.
Load gauge	See "gauge".
Lug –	
crimped	An attachment to the end of a wire for an electrical connection made using a compression or crimping tool.
terminal	A crimped, bolted or a soldered piece with a hole, used to terminate a wire for electrical connection.
Mast*	See "pole".
Mast arm*	See "bracket arm" or "cantilever".
Maximum sag	The sag of conductors either at maximum conductor temperature or under a given radial ice loading, whichever is greater.

Terms marked with an asterisk (*) are not preferred. Use preferred terms.	
Maximum operating wind speed	The maximum wind speed in which vehicles will continue to be operated at their normal speed. The wind speed selected for pantograph security calculations. Typically 55 mph for LRT Systems.
Messenger	The uppermost conductor in a catenary system. The conductor which hangs in the approximate shape of a catenary from which the contact wire is suspended by hangers.
MH	Manhole
Middle ordinate*	See “stringline”.
Midpoint anchor	The point approximately midway between two balance weights of a tension length of auto-tensioned equipment where the catenary is anchored against along-track movement.
Midpoint guy or tie wire*	The span guy that provides the midpoint restraint in auto-tensioned equipment.
Midpoint guy pole	The pole, normally with a down guy, that takes the load from the midspan guy.
Midspan offset (MSO)	The deviation of the static contact wire from the superelevated centerline of track at midspan.
MOW	Maintenance of Way Division of Owner
MPA	Midpoint Anchor assembly
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
NESC	National Electrical Safety Code
No-load tension or unloaded tension*	The tension to be applied to a messenger alone so that, once the contact wire is suspended from the messenger, the messenger assumes its desired final sag and tension.
Non-riding*	See “out-of-running”.
OCS	Overhead Contact System
O&M	operations and maintenance
Offset –	
contact wire offset	The deviation of the static contact wire from the normal center – line of the track.
Pole offset	The dimension of the centerline of the pole from the centerline of the track.
Out-of-running (OOR) catenary	The portion of catenary in multiple catenary spans that does not provide for passage for the pantograph because it is higher than, or offset from, the in-running catenary.
Overhead Contact System (OCS)	That part of the traction power system comprising the catenary (or single contact wire), aerial feeders, catenary supports, foundations, balance weights and other equipment and assemblies, that delivers electric power from the traction substation to rail vehicles.
Overlap	That portion of the overhead contact system where the contact and messenger wires of two adjoining tension lengths overlap before terminating.

Terms marked with an asterisk (*) are not preferred. Use preferred terms.	
Overlap poles	The structures which position the two contact wires in parallel within an overlap section.
Overlap span	That portion of the Overhead Contact System between two structures, where the contact and messenger wires of two adjoining tension lengths overlap, thus allowing pantographs to transition from one tension length to the next under power.
Overpass or overbridge*	Where a street, Pedestrian walkway or railway crosses above the LRT tracks.
Pan*	An alternative name for the Collector Head of a pantograph.
Pantograph	A current collection device fitted on top of an electrically powered rail vehicle, hinged to vary in height as it rubs along the underside of the contact wire.
Pantograph clearance envelope	See "Envelope, pantograph clearance envelope"
Pantograph head	The uppermost part of the pantograph which is fitted with the current collector.
Pantograph Security	The analysis of the lateral relationship between pantograph and contact wire that makes due allowance for vehicle and pantograph sway, track tolerances, superelevation, erection tolerances, windage on wires and poles.
Pantograph sway	Lateral displacement of the pantograph induced by vehicle roll and lateral shock loads. Typical maximum value is 1 1/2 inch each way
Pantograph up-lift	The distance the contact wire is lifted as a pantograph passes.
Pantograph pressure or Pantograph up-thrust*	The nominal upward force exerted by the pantograph on the contact wire. Typically 18 to 22 pounds.
Parallel running (length)	The design length where the two parallel contact wires in an overlap are suspended at the same height.
PCD	Pitch Circle Diameter
Pendulum support	A type of support using two parallel hinges typically 12-24 inches long to support the contact wire keeping the contact wire vertical as it lifts freely.
Pole or mast*	An independent slender vertical structure with or without guy, used to support some part of the OCS.
Pole cap	The attachment over the top of a pole to prevent intrusion of rain water. Ornate designs may be called "Finials".
Pole encumbrance	The across-track outside dimension of a pole and its attachments at vehicle level.
Pole face	<ol style="list-style-type: none"> 1. The side of the pole to which the cantilever or bracket arm is attached. 2. The side of the pole facing the track.
Portal	A frame support structure consisting of vertical columns supporting each end of a horizontal beam.
Pre-emption device	A switch operated automatically by LRV's in city streets, which controls traffic signals to their favor.
Preformed End Fitting	A trade name for a wrap-around type of dead end or guy grip.

Terms marked with an asterisk (*) are not preferred. Use preferred terms.	
Presag	The static difference between the average contact wire height at the end hangers in a span and the height at midspan. Typically span/1000 in value.
Prestress (of conductors)	The erection tension applied to conductor at a higher tension than normal to reduce the short-term wire creep.
Profile (overhead)	The vertical alignment of the OCS conductors relative to the track.
Pulley	A pulley block used in messenger support and catenary termination systems.
Pull off/push off	The registration towards or away from centerline of track in relation to the pole.
Rail bond	See "bond".
Radial load	The horizontal load on a structure applied by conductors due to deviation of the contact wire at registrations.
Rake	Lean of the pole from vertical.
Registration	Lateral support of conductors to maintain a fixed horizontal location relative to the track.
Rigid trolley system	An overhead contact system using an un-tensioned contact wire, relying on structural support at close spacing to supply the necessary rigidity.
Riser	A vertical cable supplying power upward from an underground feeder system to the OCS.
ROW	Right-of-way
RMS	Root-mean-square
R,S & I	Rules, Standards and Instructions
Rubbing strip*	See "Contact Strip"
Ruling span	See "equivalent span".
Running edges	The inside faces of the rail heads of a track.
SA	Surge Arrester
Saddle	The fitting that supports a hanger on the messenger wire, sometimes fitted with an insulated lining to prevent current entering the hanger.
Sag	The difference between the average heights of the conductor at adjacent supports and its height at the lowest point in the span.
Sagging	The act of installing messengers and other conductors to the correct tension by measuring conductor sag.
Sag-tension charts	Charts referred to during wire stringing that give conductor tensions related to conductor temperature during the sagging operation.
SCW	Single Contact Wire (System)
Sectionalizing or sectioning*	The division of an electrical distribution system or network into electrical sections.
Section break	An electrical break in the overhead contact system permitting isolation of a sections of catenary electrically.
Section insulator or section isolator*	A device for dividing a contact wire (and messenger wire) into two electrical sections while maintaining mechanical continuity and a continuous path for the pantographs.

Terms marked with an asterisk (*) are not preferred. Use preferred terms.	
Shop door bridge	A device in doorways of maintenance shops that bridges the gap in the contact wire which is needed to allow the overhead doors to close.
Sidewalk guy	See “guy”.
Single wire system*	See “catenary – single contact wire”.
SL	Stringline
Sleeve –	
pipe sleeve	A short length of smaller diameter pipe fitted into a larger diameter pipe to reduce the internal diameter of the larger pipe.
sleeve foundation	A custom designed circular concrete tube placed in a drilled hole to provide a foundation for an embedded pole.
chaffing sleeve	A sleeve around a conductor to reduce damage from abrasion.
reinforcing sleeve	A steel sleeve placed around a steel pole at ground line to protect against corrosion damage.
repair sleeve	A sleeve around a conductor to repair local electrical damage.
Small Part Steelwork (SPS)	Steel brackets, frames, links and yokes, etc, which are cut from stock steel sections for attachment of catenary assemblies, but not constituting part of a principal support structure.
Single wire system	See “catenary”.
Soffit	The underside of a tunnel roof or bridge deck.
Span or Actual Span Length	The horizontal length of contact wire between two adjacent support points (not necessarily the distance or difference in stationing between the support structures).
Span guy	See “Guy, Span Guy”
Span length	The distance along track between structures determined by difference in stationing.
Span width	The distance across track or roadway (may be skewed) between the columns of a portal, headspan, or cross-span.
Spiral	The transition from tangent to curve track along which superelevation increases from zero to the selected value for the curve, and vice versa.
Spout	See “cable outlet”.
Square mil	One thousandth part of the area of a one inch sided square.
STA	Station (for survey or location purposes)
Stagger	The offset of the contact wire from the superelevated track centerline by registration at each support, that causes the contact wire to sweep side to side over the pantograph head during vehicle operation.
Stand-off insulator	See “insulator”.
Station Equation	Typically the mathematical adjustment at a point along an alignment where the normal stationing is interrupted or restarted.
Steady span	A cross span guy for contact wires, usually the lower of two horizontal span guys.

Terms marked with an asterisk (*) are not preferred. Use preferred terms.	
Steady arm or registration arm*	The lateral restrainer on the contact wire at a structure.
Step and touch potentials	The potential difference between points of contact – if between hand and feet it is called “touch”, if between feet, “step” potential. (See IEEE Dictionary)
Stringing	Installation of overhead wires under tension.
Stringline	The distance between the track arc and its chord between catenary support structures, measured at midspan.
Structure	A principal support for the OCS conductors, normally including foundation, pole(s), and cantilever(s)/bracket arm(s) or headspan/cross-span; or eyebolts and cross-span.
Subassembly	A configuration of components forming part of a larger assembly.
Superelevation effect	Displacement from the vertical track centerline due to track superelevation.
Surge Arrester or Lightning Arrester*	A device typically mounted on OCS poles and connected to the OCS, designed to protect the OCS and adjacent equipment, e.g. traction power substations and feeder cables, against lightning. Surge arresters typically provide a path to ground through variable resistance elements.
Synthetic guy strand	A synthetic rope material used in cross-span guying.
System depth* or System height	The vertical distance between messenger and contact wires, at the support structure.
Tensioning	A method of controlling sag in an OCS by tension or by weight.
Tension length or Tension section*	A length of OCS between two corresponding terminations with automatic tensioning or fixed terminations.
TES	Traction Electrification System comprising the Traction Power System (TPS) and the Overhead Contact Systems (OCS).
TOR	Top of rail (as a vertical datum)
TPFS	Traction Power Feeder System
TPS	Traction Power System, comprising the Traction Power Substations (TPSS) and the Traction Power Feeder System (TPFS) (i.e. ductbanks and traction power feeder and return cables).
TPSS	Traction Power Sub-Station
Track raising allowance	An allowance of vertical clearance specified when determining minimum contact wire heights, to cater for future lifting of tracks.
Track tolerances –	Variations from design dimensions of track.
cross level	Allowable variation between the levels of the two rails (or the designated difference in levels on superelevated track).
lateral	Allowable variation in the track alignment.
track gauge	Allowable variation from 4 feet - 8 1/2 inch.
vertical	Allowable variation in track height.
Travelers	Sheaves used in pulling wires during stringing preferably with one “cheek” that can be opened for inserting wires and pull lines.

Terms marked with an asterisk (*) are not preferred. Use preferred terms.	
Trailing turnout	A turnout oriented to junction two tracks converging from behind in the normal direction of travel.
Trolley wire *	See Contact wire.
Tunnel support	A catenary, feeder, or return wire support for use in tunnels and normally mounted in the tunnel soffit.
Turnout	The arrangement of a track switch and a frog with closure rails by which vehicles can be diverted from one track to another.
UL	Underwriters Laboratory
Underpass or Underbridge*	Where a road or river crosses beneath the LRT tracks.
Underbridge supports	OCS supports used beneath overpasses and normally attached to their soffits.
Uplift –	The difference in height of contact wire when at rest and when subjected to an upward force due to current collectors passing.:

PART 2 - PRODUCTS

Not Used

PART 3 - EXECUTION

Not Used

PART 4 - MEASUREMENT AND PAYMENT**4.1 MEASUREMENT**

Not Used

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 34 23 35.99**OCS POLE PAINTING****PART 1 - GENERAL****1.1 SUMMARY**

- A. The Work specified in this Section covers the manufacture, supply, and application of all materials and methods used for factory painting of OCS poles.
- B. At various locations on the streetcar system, hot-dipped zinc galvanized coated poles shall be painted with an exterior three-coat paint application over the galvanizing. A general description of the required finish required on pole types throughout the system is given below. The contractor shall verify these with the Engineer prior to procurement.
 - 1. All poles located on Main Street south of Truman Road shall be hot-dipped galvanized only, unless otherwise directed by the Engineer.
 - 2. All poles located on Main Street between Truman Road and 7th Street shall be painted black only, unless otherwise directed by the Engineer.
 - 3. All poles located on Main Street north of 7th Street shall be painted black only, unless otherwise directed by the Engineer.
 - 4. All poles located on Delaware Street, 3rd Street, 5th Street, Grand Boulevard, Oak Street, and the non-revenue alignment shall be painted black only, unless otherwise directed by the Engineer.

1.2 RELATED SECTIONS

- A. The Contractor shall familiarize himself with the contents of the following Sections of these Specifications:
 - 1. SECTION 01 33 00 – Submittal Procedures
 - 2. SECTION 34 23 37 – OCS Tubular Steel Poles
 - 3. SECTION 34 23 37.11 – OCS Pole Ornamentation

1.3 SYSTEM DESCRIPTION

- A. Painted OCS poles shall be supplied from the manufacturer in a finished condition. Any paint damage requiring field touch-up painting shall conform to these Specifications.
- B. The Contractor shall be responsible for this Work in its entirety.

1.4 REFERENCES

- A. The following standard shall apply and are made a part of this Specification:
 - 1. American National Standards Institute (ANSI)

1.5 SUBMITTALS

- A. All submittals shall be made in accordance with SECTION 01 33 00 – Submittal Procedures, except as modified herein.
- B. Color samples shall be submitted to the Engineer for Approval prior to application to poles.

- C. Paint data, preparation, and application procedures as specified shall be submitted to the Engineer for Approval prior to painting.

1.6 DELIVERY, STORAGE AND HANDLING

- A. All painted poles shall be handled and stored by the Contractor so as to not damage the paint or coatings.
- B. The storage of paint and its associated mixes shall be in accordance with the paint manufacturer's written instructions and shall not alter the composition of the paint such that the qualities are altered or otherwise lost.
- C. The Contractor shall insure that the storage of all flammable paints and solvents is in accordance with all Federal, State, and Local requirements.

1.7 WARRANTY

- A. The finished coating shall be guaranteed to last a minimum of 5 years, with no visible paint peeling, blistering, cracking, fading, or surface corrosion evident or occurring within that period.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. The term Paint, as used herein, includes coatings, emulsions, enamels, varnishes, paints and other protective sealers, whether used as a prime, intermediate or finish coat.
- B. The types of paint approved for use on OCS poles are as follows:
 - 1. Primer paint to be a rust-inhibitive, high build epoxy coating, quick dry-recoatable, applied over a finished hot-dipped galvanized base component system having 1.5 mil thick (minimum) paint dry-film coat; equivalent to Sherwin Williams Industrial Recoatable Epoxy Prime (B67 Series).
 - 2. Intermediate and Top Coating - To be acrylic polyurethane resin coating resistant to weather, abrasion and salt solutions, fast-dry product having a wide selection of available colors, semi-gloss, two-coat system, each coating to be 1.5 mil dry-film thickness, equivalent to Sherwin Williams Industrial Hi-Solids Polyurethane Resin (B65 Series).
- C. All paint products and coatings shall be selected, purchased, and used on the basis of a normal exterior exposure in an urban area with low humidity, intense sunlight, and temperatures ranging from -20 degrees to 120 degrees Fahrenheit. All paint products and coatings must be designed for this environment, having excellent resistance to corrosion, weathering, and demonstrating superior color retention.
- D. Paints intended for use in the field shall be stored in sealed containers that legibly show the designated name, formula, batch number, color, quantity, date of manufacture, manufacturer's number and directions including storage, special precautions, and warnings.
- E. The Contractor shall provide the following information for all paint used:
 - 1. The paint manufacturer and product key number
 - 2. Manufacture batch lot number
 - 3. Color

4. Directions and instructions for storage and field touch-up application
- F. Contractor shall supply five gallons of primer and five gallons of each color of paint to the Owner for later use.

2.2 PAINTING PROCESS

- A. Painted surfaces shall have a minimum three-coat application. The coating shall consist of a primer, intermediate, and finish layer, each with a minimum dry 1.5 mil thickness. The total paint thickness shall not be less than 5 mils dry (excluding galvanizing) and shall be in accordance with the paint manufacturer's instructions.

PART 3 - EXECUTION

3.1 INSPECTION

- A. All paint and its application shall be subject to inspection by the Engineer.

3.2 INSTALLATION

- A. Painted surfaces shall receive a minimum of three coats.
- B. Unless otherwise recommended by the paint manufacturer, all paint applications shall be performed when the ambient temperature is between 45 degrees Fahrenheit and 95 degrees Fahrenheit. All paints shall be applied only to surfaces that are completely dry, clean, and free of surface moisture, dirt, dust, oil, mill scale, and detrimental coatings which will cause the paint to lose its bonding properties. The Contractor shall follow all requirements and suggestions provided by the paint manufacturer. Solvent clean all surfaces prior to the application of the prime coat. After 1 week, spot test the paint adhesion to the galvanizing to insure a permanent bond. Brush blast clean the entire galvanized surface if paint test proves unacceptable, in accordance with the paint manufacturer's recommendations.
- C. Items not to be painted, which are in contact with or adjacent to surfaces scheduled for painting, shall be removed or protected prior to surface preparation and painting operations. All masking and protective tapes shall be totally removed, without leaving residue, upon completion of the painting operations. Paint shall not be applied to any insulators, cable insulation, or other OCS components that are not specifically required to be painted.
- D. Prime Coat
 1. Primers shall be capable of remaining in satisfactory condition for 6 months without the protection of a finish coat, for all field painting applications.
 2. Primers shall have sufficient penetrating and wetting properties to insure good coating regardless of the presence of light scale, or light rust on the surface to be painted.
- E. Intermediate Coat
 1. The intermediate coat shall be of a composition similar to the final finish coat, as recommended by the paint manufacturer.
- F. Finish Coat
 1. The finish coat shall be a coating suitable for protecting the surfaces to which it is applied. It shall completely hide the primer and intermediate coats and shall have no visible streaks, blisters, large runs, or obvious color or surface imperfections.

2. Drying time to a tack free condition shall not be more than 24 hours.

3.3 APPLICATION

- A. Paint shall be factory applied by dip, spray, or electro-coating except as herein specified. Field touch-up painting shall be by clean, dry brush or roller application, in accordance with paint manufacturer's instructions. At the time of application, all paint mixes shall show no signs of deterioration and be thoroughly mixed prior to applying. Powder coating over hot-dipped galvanizing shall be considered acceptable, pending demonstration of its in-service performance and application and shall be approved by the Engineer prior to manufacture.
- B. Paints of different manufacturers shall not be mixed together. Thinning is acceptable prior to application where necessary to suit conditions of surface, temperature, weather and method of application with not more than one pint of approved thinner per gallon of paint or as per the paint manufacturer's instructions.
- C. Paint shall be applied so the final finished surfaces shall be free of visible runs, drops, blisters, brush marks, and variation of color, texture, and finish.
- D. Each coat shall be applied as a film of uniform thickness, not less than 1.5 mils dry. Special attention shall be given to insure that all surfaces including edges, corners, crevices, welds, voids, and base plates receive a film thickness equivalent to that of adjacent painted surfaces.
- E. Sufficient time shall elapse between successive coats to permit proper drying. The application of another coat shall not cause the lifting or loss of adhesion of the undercoat.

3.4 FIELD QUALITY CONTROL

- A. All painting activities shall be in accordance with these Specifications, and are subject to inspection at any time by the Engineer.
- B. All paint which is unacceptable as applied, shall be removed or repaired in accordance with the paint manufacturer's instructions, and inspected for Approval by the Engineer at the Contractor's expense.

PART 1 - MEASUREMENT AND PAYMENT

1.1 MEASUREMENT

- A. The quantities of accepted work will be measured in the following units. All measurements will be plan measure except for authorized changes.
 1. Description: Lump Sum

1.2 PAYMENT

- A. Payment will be made at the respective unit or lump-sum price listed in the proposal and shall be full compensation for all labor, materials, and equipment necessary to complete the respective unit in place. There will be no separate measurement or payment for any item of work not specifically identified and listed in the proposal, and all such work shall be considered a subsidiary item with all costs pertaining thereto included in the prices for other items listed in the proposal. At the Engineer's option, partial payment may be made for any lump sum item listed in the proposal, providing that the Contractor is diligently and satisfactorily pursuing full completion of such partially complete item in accordance with the approved job progress schedule.

END OF SECTION

SECTION 34 23 37**OCS TUBULAR STEEL POLES****PART 1 - GENERAL****1.1 SUMMARY**

- A. This Section covers furnishing, fabrication, hot-dip galvanizing, hard marking, labeling, and delivery of new tapered tubular steel poles and accessory parts, for use as part of the Overhead Contact System (OCS) as shown on the Contract Drawings.
- B. The Contractor shall fabricate all OCS tapered tubular steel poles per the Contract Drawings.
- C. There will be 5 general configurations of OCS poles on the project; sole use OCS poles, OCS poles with street lighting, OCS feeder poles, Ornamental OCS poles, and OCS poles with traffic signal accessories. In some cases there will be combinations of these configurations. OCS pole finish may vary on the project, possibly utilizing both galvanized and painted finishes. The Contractor shall verify OCS pole types and finishes with the Engineer prior to procurement. See SECTIONS 34 23 37 – OCS Tubular Steel Poles, 34 23 37.11 – OCS Pole Ornamentation, 34 23 35.99 – OCS Pole Painting, and the Missouri Department of Transportation Governing Specifications and Special Provisions for related Specifications. OCS poles shall be procured based on these Specifications and Contract Drawings, in conjunction with Approval from the Engineer.
- D. A summary of the possible pole combinations is provided below.
 - 1. Regular (Non-Feeder) OCS poles may be ornamental or simple tapered tubular. They may also be combined with lighting and/or traffic accessories.
 - 2. OCS Feeder poles shall be simple tapered tubular poles with spouts. Feeder poles will not be ornamental poles. Feeder poles shall not be combined with lighting or traffic accessories.
- E. A summary of the pole types based on location is provided below.
 - 1. All poles located on Main Street south of Truman Road shall be simple tapered tubular poles only, unless otherwise directed by the Engineer.
 - 2. All poles located on Main Street between Truman Road and 7th Street shall be ornamental, unless otherwise directed by the Engineer.
 - 3. All poles located on Main Street north of 7th Street shall be simple tapered tubular poles only, unless otherwise directed by the Engineer.
 - 4. All poles located on Delaware Street, 3rd Street, 5th Street, Grand Boulevard, Oak Street, and the non-revenue alignment shall be simple tapered tubular poles only, unless otherwise directed by the Engineer.

1.2 RELATED SECTIONS

- A. SECTION 01 33 00 – Submittal Procedures
- B. SECTION 01 43 00 – Systems Quality Assurance
- C. SECTION 34 23 35.99 – OCS Pole Painting

- D. SECTION 34 23 37.11 – OCS Pole Ornamentation
- E. Specifications for Street Lighting Attachments can be found in the Street Lighting Specifications.
- F. Specifications for Traffic Signal Attachments can be found in the Traffic Signal Specifications.

1.3 REFERENCE STANDARDS

- A. The latest edition of the following reference specifications shall also govern the Work covered by this Section unless otherwise noted.
 1. ASTM A36 Structural Steel
 2. ASTM A53 Pipe, Steel, Black and Hot-dipped, Zinc Coated, Welded and Seamless
 3. ASTM A123 Zinc Coating (Hot-Dip Galvanized) on Iron and Steel Products
 4. ASTM A153 Zinc Coating (Hot-Dip) on Iron and Steel Hardware
 5. ASTM A325 High Strength Bolts for Structural Steel Joints.
 6. ASTM A370 Mechanical Testing of Steel Products
 7. ASTM A449 Specification for Quenched and Tempered Steel Bolts and Nuts
 8. ASTM A500 Specification for Circular cross-section Tubular Pole (Fy = 42 ksi)
 9. ASTM A563 Carbon and Alloy Steel Nuts
 10. ASTM A572 High Strength Low-alloy Columbium- Vanadium Steels of Structural Quality
 11. ASTM A595 Steel Tubes, Low Carbon, Tapered for Structural Use
 12. ASTM A633 Standard Specification for Normalized High-Strength Low-Allow Structural Steel Plates
 13. ASTM E269 Standard Definitions of Terms Relating to Magnetic Particle Examination
 14. ASTM E709 Standard Recommended Practice for Magnetic Particle Examination
 15. ASTM F436 Hardened Steel Washers
 16. ASTM F593 Stainless Steel Bolts, Hex Cap Screws and Studs
 17. AISC --- Code of Standard Practice for Buildings and Bridges
 18. AISC --- Manual of Steel Construction
 19. AWS D1.1 Structural Welding Code - Steel
 20. ASNT SNT-TC-1A Personnel Qualifications and Certification in Nondestructive Testing

- | | | |
|-----|---------------------|---|
| 21. | MILSPEC DOD-P-21035 | Paint, High Zinc Dust Content Galvanizing Repair |
| 22. | FED SPEC FF-T-79166 | Type 1 Form 1 Hot-Dip Galvanized Drop Forged Steel Quenched and Tempered Hardware |

1.4 SUBMITTALS

- A. Submittals shall be made in accordance with the requirements of SECTION 01 33 00 – Submittal Procedures, except as modified herein:
1. The Contractor shall submit the specifications for welding procedures and processes, certificates of qualifications of welders, welding operators, tackers, and welding inspectors for acceptance.
 2. The Contractor shall submit for review shop drawings of all pole types and capacities required. The shop drawings shall be to scale, giving complete information necessary for the fabrication of the poles. The drawings shall also indicate all fittings, holes, and accessories. The locations, sizes and types of all welds shall also be included on the drawings.
 3. The Contractor shall submit for review, prior to commencing fabrication, the manufacturer's certificates of compliance, or certified laboratory test reports. The reports shall demonstrate the compliance of all raw materials and fabrication products. Included shall be a listing of all standards designated by the manufacturer, as indicated.
 4. The Contractor shall furnish copies of test reports of all factory tests as required by these specifications and referenced standards.

1.5 QUALITY CONTROL/QUALITY ASSURANCE

- A. Quality control activity shall be in accordance with SECTION 01 43 00 – Systems Quality Assurance except where varied herein:
- B. Qualifications for welding work
1. Quality of welding processes and welding operations shall be in accordance with current AWS D1.1.
 2. Provide certifications that welders employed have satisfactorily passed AWS qualification per current AWS requirements.
- C. Source Quality Control: Material and fabrication procedures are subject to inspections and tests in the mill, shop, and field. These inspections and tests shall not relieve the Contractor of the responsibility for providing materials and fabrication procedures that are in compliance with the requirements.
- D. Shop Assembly: Preassemble components in the shop to the maximum extent possible. In order to simplify field assembly of units, clearly mark components for easy assembly at the site of installation.
- E. Material Testing: The chemical compositions and appropriate mechanical properties shall be determined for all materials used, either by obtaining manufacturer's certificates of compliance or by laboratory testing at a facility which is acceptable to the Engineer.

- F. Weld Testing
1. The services of an AWS Certified Welding Inspector shall be provided by the Fabricator to perform specified fabrication and verification inspection of welding procedures and personnel, and to perform weld tests as specified herein. Approval of the Welding Inspector shall be obtained from the Engineer.
 2. A visual inspection of all welds shall be performed in conformance with the AWS code.
 3. Weld testing shall be performed on a sample number of poles selected at random by the Engineer, comprising 20% of the total number of poles.
 4. Equipment, procedures, personnel for weld testing, and test reports shall conform to the requirements of AWS D1.1, Section 6 - Inspection.
 5. Weld testing shall consist of:
 - a. Ultrasonic testing conforming to the requirements of AWS D1.1, section 6
 - b. Magnetic particle testing conforming to the requirements of ASTM E709
 6. The poles selected for testing shall be tested by the ultrasonic and magnetic particle methods.
 7. Ultrasonic testing shall be performed on the complete penetration welds between the pole shaft and pole base, and on any circumferential welds in the pole shaft, for each pole being tested. Magnetic particle testing shall be performed on all other welds including longitudinal seam welds, welds at handholes, etc.
 8. For each tested pole that is found to be deemed unacceptable, weld testing shall be performed on another sample pole selected at random by the Engineer.
 9. Results of weld testing shall be deemed acceptable or unacceptable in accordance with AWS D1.1, sections 8, 9 or 10.
 10. Welds found to be unacceptable shall be repaired as specified, and retested at the Contractor's expense.
- G. Impact Testing: Structural steel materials for base plates and pole shafts shall be tested for impact toughness in accordance with the Charpy V-notch test as specified in ASTM A370. The minimum energy value shall be 15 ft-lbs at 0°F.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. During fabrication and delivery, steel products shall be handled and transported in a manner that will prevent damage occurring to the structural steel, galvanizing, and surface coatings.
- B. Material shall not be stored in contact with the ground. It shall be stored in a manner and location that will not cause deterioration of the material.
- C. Any damage to the material and equipment shall be the Contractor's responsibility and all repairs shall be accomplished by the Contractor in accordance with the manufacturer's instructions, at the Contractor's expense.

PART 2 - PRODUCTS**2.1 MATERIALS**

- A. OCS Tapered Tubular Steel Poles
1. Tapered tubular steel poles shall be furnished complete with base plate, pole shaft, stiffeners, handholes, feeder spouts, and fittings.
 2. Poles shall be single ply.
 3. Poles shall be fabricated with the pole shaft having multiple faceted or circular cross sections.
 4. Pole shafts shall be fabricated from one structural steel material type conforming to the following ASTM Specification:
 - a. Multiple Faceted or Circular cross section Tapered Tubular Pole including Joint Use Poles - A595, Grade A steel
 - b. Multiple Faceted Tapered Tubular Pole including Joint Use – A572, Grade 55 steel
 5. Base Plates: Base plates shall be fabricated from structural steel conforming to one of the following Specifications:
 - a. ASTM - A572, Grade 50 steel
 - b. ASTM – A633, Grade 50 steel
 6. Poles shall have no spliced joints.
 7. Pole Attachments
 - a. Pole and handhole reinforcements shall be fabricated from steel of the same type and grade as specified for the pole shafts.
 - b. Feeder spouts (outlets) shall be standard steel pipe conforming to ASTM A53, Type S, Grade B.
 - c. Pole caps shall be fabricated from steel compatible with the pole shaft, and fitted with three stainless steel set screws.
 - d. Handhole cover screws shall be stainless steel hex head set screws.
 - e. Lighting attachments will require holes through the pole shaft to accommodate wiring.
 8. Weld filler shall be selected in compliance with the welding procedures of AWS D1.1. and shall be capable of producing satisfactory designed strength.
 9. All steel shall be handled carefully to keep it clean, and it is to be treated with the care and concern that should be to any product whose finished surfaces are to remain as prepared in the shop. The steel shall be kept free and clean of all foreign matter that may affect the natural oxidation of the steel. The Contractor shall immediately remove any foreign matter found on the steel.
 10. Hot-dip galvanizing shall be in accordance with ASTM A123 for fabricated pole assemblies and ASTM A153 for hardware.
 11. Miscellaneous structural steel shall conform to ASTM A36.

2.2 FABRICATION

- A. General: Poles, base plates, and fittings, including handholes, grounding lugs, "J" hooks and base partition accessories shall be fabricated to the dimensions indicated on the Contract Drawings or the Contractor's OCS Pole design shop drawing, as approved by the Engineer.
- B. Methods: Poles, fittings, accessories, and base plates shall be fabricated by methods conforming to AISC Specifications, except as specified herein.
- C. Welding Procedures: Welding procedures, welders, welding operations, and tackers shall conform to the provisions of the current AWS D1.1, Section 2, Design of welded connections; Section 3, Workmanship; Section 4, Techniques; and Section 8, 9 or 10.
- D. Preheat: Preheat base plate immediately prior to welding pole shaft to base plate.
- E. Weld Repair: Welds found to be unacceptable shall be repaired in accordance with the provisions of AWS D1.1, Section 3, Workmanship.
- F. The connections shall be welded in accordance with the Contract drawings and shall be fabricated in the shop, using E70xx electrodes in compliance with the welding procedures of AWS D1.1. Contractor shall design weld size and configurations based on load ratings given in drawings and AWS guidelines.
- G. Allowable Tolerances are as follows:
1. Tapered Tubular pole diameter shall be within 1/16 inch of the design diameter, and shall be within 1/16 inch of perfect round.
 2. Pole wall thickness shall be within plus 10%, but no less than the design thickness.
 3. Pole straightness shall be within 1/8 inch per 5 feet of pole length.
 4. Tolerances for base plates shall be as follows:
 - a. Bolt Circle Diameter: + 1/16 inch, -0 inch
 - b. Hole Diameter: + 1/16 inch, -0 inch
 - c. Location of Holes: + 1/16 inch in each direction
- H. Pole Type Identification Number is used to identify the pole type which shall be stamped in 1-inch high letters by a minimum 1/16 inch deep in the vertical edge of the base plate before galvanizing. Pole Type Identification Number shall be applied to the opposite side from the handhole. Pole Type Identification Numbers shall be clearly readable after galvanizing.
1. Pole Type Identification Numbers shall match the designations on the pole assembly drawings.
- I. For ornamental bases, cladding, globe arms, accessories and connections see SECTION 34 23 37.11 – OCS Pole Ornamentation.
- J. Street Lighting Attachments on OCS Poles shall be in accordance with Missouri Department of Transportation Governing Specifications and Special Provisions, in conjunction with Approval from the Engineer.
- K. Traffic Signal Attachments on OCS Poles shall be in accordance with Missouri Department of Transportation Governing Specifications and Special Provisions, in conjunction with Approval from the Engineer

2.3 FACTORY TESTING

- A. Poles shall be factory tested according to the provisions in SECTION 34 23 80 – OCS Testing.

PART 3 - EXECUTION

Not Used

PART 4 - MEASUREMENT AND PAYMENT**4.1 MEASUREMENT**

- A. The quantities of accepted work will be measured in the following units. All measurements will be plan measure except for authorized changes.
 - 1. Description: Lump Sum

4.2 PAYMENT

- A. Payment will be made at the respective unit or lump-sum price listed in the proposal and shall be full compensation for all labor, materials, and equipment necessary to complete the respective unit in place. There will be no separate measurement or payment for any item of work not specifically identified and listed in the proposal, and all such work shall be considered a subsidiary item with all costs pertaining thereto included in the prices for other items listed in the proposal. At the Engineer's option, partial payment may be made for any lump sum item listed in the proposal, providing that the Contractor is diligently and satisfactorily pursuing full completion of such partially complete item in accordance with the approved job progress schedule.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 34 23 37.11**OCS POLE ORNAMENTATION****PART 1 - GENERAL****1.1 SUMMARY**

- A. For traffic signal attachment details see traffic signal specifications and drawings.
- B. For lighting attachment details see lighting specifications and drawings.

PART 2 - PRODUCTS**2.1 MATERIALS**

- A. Not Used

PART 3 - EXECUTION

- A. Not Used

PART 4 - MEASUREMENT AND PAYMENT**4.1 MEASUREMENT**

- A. The quantities of accepted work will be measured in the following units. All measurements will be plan measure except for authorized changes.
 - 1. Description: Lump Sum

4.2 PAYMENT

- A. Payment will be made at the respective unit or lump-sum price listed in the proposal and shall be full compensation for all labor, materials, and equipment necessary to complete the respective unit in place. There will be no separate measurement or payment for any item of work not specifically identified and listed in the proposal, and all such work shall be considered a subsidiary item with all costs pertaining thereto included in the prices for other items listed in the proposal. At the Engineer's option, partial payment may be made for any lump sum item listed in the proposal, providing that the Contractor is diligently and satisfactorily pursuing full completion of such partially complete item in accordance with the approved job progress schedule.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 34 23 40

OCS WIRE AND CABLE

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section covers procurement and installation of wire and cable for OCS use within the streetcar system as described in SECTION 34 23 10 – OCS Description and General Requirements.
- B. Work under this Section includes the procurement of wire conductors and insulated cable for use as part of the installation of OCS equipment in accordance with OCS Wiring Layout Drawings, OCS Wiring Schedules, Traction Electrification Sectionalizing Diagrams, and Standard OCS System Drawings contained in the Contract Drawings.
- C. The wire to be procured and installed includes bare wire conductors used as OCS contact wire, bare feeder wires, bare jumper wires, feeder cables, jumper cables, terminations, ground wires, and all other OCS associated components
- D. The cable to be procured and installed includes insulated conductors used as feeders, or jumpers electrically connecting and passing current, either directly or indirectly from the outgoing terminal of pole mounted switches to the operational contact wire of the OCS.

1.2 RELATED SECTIONS

- A. DIVISION 01 – General Requirements
- B. SECTION 01 33 00 – Submittal Procedures
- C. SECTION 01 43 00 – Systems Quality Assurance
- D. SECTION 26 – Traction Power Specifications
- E. SECTION 34 23 10 – OCS System Description and General Requirements
- F. SECTION 34 23 50 – OCS Assemblies, Components and Fittings
- G. SECTION 34 23 70 – OCS Installation
- H. SECTION 34 23 80 – OCS Testing

1.3 REFERENCED STANDARDS

- | | | | |
|----|------|----------------|--|
| A. | ASTM | A368-95a | Standard Specification for Stainless Wire Strand |
| B. | ASTM | A475-03 | Standard Specification for Zinc-Coated Steel Wire Strand |
| C. | ASTM | A492-95 | Standard Specification for Stainless Steel Wire Rope |
| D. | ASTM | A555/ A555M-05 | Standard Specification for General Requirements for Stainless Steel Wire and Wire Rods |
| E. | ASTM | A580/A580M-06 | Standard Specification for Stainless Steel Wire |
| F. | ASTM | B1 | Standard Specification for Hard-Drawn Copper Wire |

-
- | | | | |
|----|------|-----|--|
| G. | ASTM | B3 | Standard Specification for Soft or Annealed Copper Wire |
| H. | ASTM | B8 | Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft |
| I. | ASTM | B47 | Standard Specification for Copper Trolley Wire |

1.4 SUBMITTALS

- A. Submittals shall be made in accordance with the requirements of SECTION 01 33 00 – Submittal Procedures of the Contract Documents, except as modified herein.
- B. Technical information required
1. Submit the following information for all wires and cables:
 - a. Size
 - b. Type
 - c. Material
 - d. Number of and diameter of individual wires
 - e. Overall diameter
 - f. Cross-section area
 - g. Weight per foot
 - h. Rated breaking load
 - i. Electrical characteristics
- C. Contact Wire
1. Submit certification verifying that the Contact wire has been designed, manufactured, inspected, and tested in accordance with the referenced standards and these specifications.
 2. Submit complete manufacturer's data.
- D. Jumper Wire
1. Submit certification verifying that the Jumper wire has been designed, manufactured, inspected, and tested in accordance with the referenced standards and these specifications.
 2. Submit complete manufacturer's data.
- E. Feeder and Feeder Jumper Cable
1. Submit certification verifying that the Feeder Cable and Feeder Jumper Cable has been designed, manufactured, inspected, and tested in accordance with the referenced standards and these specifications.
 2. Submit complete manufacturer's data.

- F. Stainless Steel Wire Rope
 - 1. Submit certification verifying that the stainless steel wire and wire rope have been designed, manufactured, inspected, and tested in accordance with the referenced standards and these specifications.
 - 2. Submit complete manufacturer's data.
- G. Galvanized Steel Wires
 - 1. Submit reports for each type of wire to be used containing the physical and mechanical properties of all components described in this Section. The conformance of components with these Specifications and Contract Drawings in the form of a manufacturer's certification shall be shown.
 - 2. Submit a certification that the galvanized steel wire and wire rope have been designed, fabricated, rated, and tested in compliance with the applicable provisions of the standards referenced in these Specifications.
 - 3. Submit complete manufacturer's data.
- H. Samples
 - 1. Submit three 12-inch long samples of each conductor or cable to the City Engineer.
 - 2. Cables shall have ends secured from fraying.
 - 3. All samples shall have rough edges at ends filed down.
 - 4. All samples shall be labeled with wire tape and intended use clearly identified.

1.5 QUALITY ASSURANCE/QUALITY CONTROL

- A. Quality Control/Quality Assurance shall be in accordance with SECTION 01 43 00 – Systems Quality Assurance except where modified within this Specification Section.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Assembly, component, and fitting materials shall be packaged, stored, handled, and transported in a manner that will prevent damage occurring to the material and any surface coatings.
- B. Wire and cable materials shall be carefully wound onto drum built suitably for that wire or cable. Where wire or cables being supplied may form part of the Owner's maintenance stocks, cable drums shall be manufactured from steel.
- C. Materials shall not be stored in contact with the ground. It shall be stored in a manner and location that will not cause deterioration of the material. It shall be labeled clearly and numbered to match the Contractor's approved design drawings.
- D. Any damage to the materials and equipment shall be the Contractor's responsibility, and all repairs shall be accomplished by the Contractor in accordance with the manufacturer's instructions, at the Contractor's expense.

PART 2 - PRODUCTS**2.1 CONTACT WIRE**

- A. The contact wire shall be solid grooved hard drawn copper. The contact wire shall conform to or exceed the requirements of ASTM B47. The contact wire size shall be 350kcmil.
- B. The contact wire shall be wound on reels, with its vertical axis normal to the barrel of the reel. The wire shall be wound evenly, tightly, and with no kinks. The diameter of the reel spindle shall be large enough to prevent excessive wire twist when running the wire out of the reel. A minimum diameter of 36 inches is permitted.

2.2 JUMPERS

- A. Full current and potential equalizing jumpers shall be 350 kcmil stranded, annealed copper cable conforming to ASTM B3 and B8 Class G or H, bare. The connections to the conductors shall be of copper or bronze.

2.3 INSULATED FEEDER CABLE AND FEEDER JUMPERS

- A. Feeder cables and feeder jumpers shall be 250 kcmil 2000 V "flex type" insulated copper cable.
- B. The size of feeder wire to be installed at each location shall be as shown on the sectionalizing schematic drawings in the Contract.
- C. Insulation shall be rated for XHHW or approved equal.

2.4 GROUND CABLES

- A. OCS Pole and Surge Arrester Ground cable sizes shall be as shown in the Drawings, unless otherwise specified.
- B. OCS Pole and Surge Arrester Ground methods shall be in accordance with the Contract Drawings, these Specifications, and the National Electric Code (NEC).
- C. Grounding Conductor
 - 1. Extra-flexible bare cable: Copper, 2/0 AWG, Class I stranding, ASTM B3, ASTM B172.
 - 2. Insulated cable: Copper, 2/0 AWG, 2 kV rated insulation.
 - 3. Splice: C-type compression connector, Burndy Hyground or approved equal.
 - 4. Exothermic weld

2.5 WIRE AND CABLE

- A. Galvanized Steel Wire and Wire Rope
 - 1. Galvanized steel wire and wire rope shall not be used on the Project unless specifically approved for each application by the Engineer.
 - 2. The physical properties of the zinc coated stranded wire shall conform to the description in Table 1 of ASTM A475.
 - 3. The weight of coating for zinc coated steel wire shall not be less than that specified in Table 4, under Class C of ASTM A475.

4. The materials shall be protected against damage during shipping and shall be wound on suitable reels. Each reel shall have a strong weatherproof tag attached which shall show the physical and mechanical properties, the steel type and ASTM designation and the name and mark of the manufacturers.
- B. Stainless Steel Wire and Wire Rope
1. Stainless steel wire rope shall be extra flexible.
 2. Stainless steel wire strand shall be manufactured and tested in accordance with the requirements of ASTM standards A368, A555, and A580.
 3. Stainless steel wire rope shall be manufactured and tested in accordance with the requirements of ASTM standards A368, A492, A555, and A580.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Installation of wires shall be per the Contract Drawings and SECTION 34 23 70 – OCS Installation, of these Specifications.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

- A. The quantities of accepted work will be measured in the following units. All measurements will be plan measure except for authorized changes.
1. Description: Lump Sum

4.2 PAYMENT

- A. Payment will be made at the respective unit or lump-sum price listed in the proposal and shall be full compensation for all labor, materials, and equipment necessary to complete the respective unit in place. There will be no separate measurement or payment for any item of work not specifically identified and listed in the proposal, and all such work shall be considered a subsidiary item with all costs pertaining thereto included in the prices for other items listed in the proposal. At the Engineer's option, partial payment may be made for any lump sum item listed in the proposal, providing that the Contractor is diligently and satisfactorily pursuing full completion of such partially complete item in accordance with the approved job progress schedule.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 34 23 50**OCS ASSEMBLIES, COMPONENTS, AND FITTINGS****PART 1 - GENERAL****1.1 SUMMARY**

- A. This Section covers the provision of assemblies, components, and fittings that make up the OCS for the streetcar system, as described in SECTION 34 23 10 – OCS Description and General Requirements.
- B. Work under this Section includes the provision of OCS equipment in accordance with the OCS Wiring Layout Drawings, Assembly Drawings, Pole and Foundation Schedules, and other related Drawings contained in the Contract Drawings.
- C. The equipment to be provided includes items associated with cantilevers, headspans, cross-spans, conductor support assemblies, feeder and jumper components, terminations, sectioning equipment, disconnect switches, surge arresters, and other components required for the complete installation of the OCS for the route and maintenance shop.
- D. All OCS equipment is energized at a nominal 750 V DC, and shall be double insulated. A minimum of two levels of electrical insulation shall be provided between the contact wire and a line pole or other grounded structure
- E. All OCS assemblies, components, and fittings shall be designed and manufactured in accordance with SECTION 01 43 00 – Systems Quality Assurance except where modified within this Specification Section.
- F. All OCS assemblies, components, and fittings shall be submitted to the Engineer for Approval, in accordance with SECTION 01 33 00 – Submittal Procedures.
- G. Installation of Assemblies, components, and fittings shall be per SECTION 34 23 70 – OCS Installation.

1.2 RELATED SECTIONS

- A. DIVISION 01 – General Requirements
- B. SECTION 01 33 00 – Submittal Procedures
- C. SECTION 01 43 00 – Systems Quality Assurance
- D. SECTION 26 – Traction Power Specifications
- E. SECTION 34 23 10 – OCS Description and General Requirements
- F. SECTION 34 23 40 – OCS Wire and Cable
- G. SECTION 34 23 70 – OCS Installation
- H. SECTION 34 23 77 – OCS Surge Arrester Installation
- I. SECTION 34 21 78 – OCS Disconnect Switch Installation
- J. SECTION 34 23 80 – OCS Testing

1.3 REFERENCED STANDARDS

- A. The pertinent provisions of the latest revisions of the codes and standards of the applicable NEMA, IEEE, ASTM, AISC, AWS, NEMA, NFPA, Federal Standard 595 and ANSI shall apply to the Work of this Section.

1.4 SUBMITTALS

- A. Submittals shall be in accordance with the requirements of SECTION 01 33 00 – Submittal Procedures, except as modified herein.
- B. The Contractor shall submit for review and approval by the Engineer, complete details for all assemblies, equipment, and components specified on the OCS Drawings provided.
- C. The Contractor shall furnish suitable illustrated catalog sheets, sufficient for the identification of all components not bearing individual identification, for all equipment and components not specified in this Section. All components for the OCS shall be submitted as shop drawings or catalog sheets, without exception. The Engineer may request submission of sample components if required for clarification.
- D. All design data, calculations, and design results shall be bound with a Table of Contents and the full volume shall bear the seal of a registered Professional Engineer qualified by experience, who personally supervised the preparation of the design.
- E. The Contractor shall submit test reports from Factory Design Tests and Factory Production Tests specified in SECTION 34 23 80 – OCS Testing.
- F. Disconnect Switches
 - 1. Submit complete manufacturer's descriptions, catalog data, and information including model numbers or serial numbers.
 - 2. Submit manufacturer's general and detail arrangement drawings, and installation instructions.
 - 3. Submit operation and maintenance manuals with a list of recommended spare parts.
 - 4. Submit installation and adjustment procedures.
- G. Wiring Assemblies, Fittings, and Components
 - 1. Submit Shop Drawings for all assemblies, fittings, and components for approval prior to manufacture. Shop drawings shall show details, dimensions, designations of the materials comprising the various components, and shall include technical, mechanical, and electrical characteristics as Specified.
 - 2. Submit samples of certain components as required by the Engineer.
- H. Insulators
 - 1. Submit Shop Drawings prior to insulator manufacture, showing details and dimension of the insulating and metal parts, describing the material composing the various parts, together with technical, mechanical, and electrical characteristics.
 - 2. Submit Certificates of compliance as applicable for the following:
 - a. Steel analysis
 - b. Analysis of other copper, bronze, and aluminum materials

- c. Hot-dip galvanizing
 - d. Adhesive materials
 - e. Insulator materials
 - f. In-service record of proposed insulators
 - g. Certified Quality Control Procedures used in the manufacturing process
3. Submit the follow data prior to insulator manufacture:
 - a. A complete set of assembly, component, and detail Drawings showing dimensions and weights
 - b. Storage and handling instructions
 - c. Test Procedures and Reports as Specified in SECTION 34 23 80 – OCS Testing
 - d. Installation procedures
- I. Brackets and Hinges
1. Submit Shop Drawings for all components for approval prior to manufacture, showing details and dimensions, and giving designations of the materials comprising the various components together with technical and mechanical, characteristics as Specified.
 2. Submit samples of certain components as required by the Engineer.
 3. Submit installation and adjustment procedures.
- J. Surge Arresters
1. Submit Shop Drawings for all components for approval prior to manufacture, showing details and dimensions, and giving designations of the materials comprising the various components together with technical, mechanical, and electrical characteristics as Specified.
 2. Submit samples of certain components as required by the Engineer.
 3. Submit installation and adjustment procedures.
- K. Fixed Terminations
1. Submit Shop Drawings for all components for approval prior to manufacture, showing details and dimensions, and giving designations of the materials comprising the various components together with technical, mechanical, and electrical characteristics as Specified.
 2. Submit samples of certain components as required by the Engineer.
- L. Warning Signs, I.D. Numbers, and Information Markers
1. Submit Shop Drawings for all components for approval prior to manufacture, showing details and dimensions, and giving designations of the materials comprising the various components together with technical, mechanical characteristics as appropriate.
 2. Submit samples of certain components as required by the Engineer.

M. Section Insulators

1. Submit Shop Drawings prior to section insulator manufacture, showing details and dimension of the insulating and metal parts, describing the material composing the various parts, together with technical, mechanical, and electrical characteristics.
2. Submit Certificates of compliance for the following:
 - a. Steel analysis
 - b. Analysis of other copper, bronze, and aluminum materials
 - c. Hot-dip galvanizing
 - d. Adhesive materials
 - e. Insulator materials
 - f. In-service record of proposed insulators
 - g. Certified Quality Control Procedures used in the manufacturing process
3. Submit the follow data prior to insulator installation:
 - a. A complete set of assembly, component, and detail Drawings showing dimensions and weights
 - b. Storage and handling instructions
 - c. Test Procedures and Reports as Specified in SECTION 34 23 80 – OCS Testing
 - d. Installation procedure
4. Submit details of any specifications for materials included in the section insulator assembly which are not covered in this specification.

1.5 QUALITY ASSURANCE/QUALITY CONTROL

- A. Quality Control/Quality Assurance shall be in accordance with SECTION 01 43 00 – Systems Quality Assurance except where modified within this Specification Section.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Assembly, component, and fitting materials shall be packaged, stored, handled, and transported in a manner that will prevent damage occurring to the material and any surface coatings.
- B. Materials shall not be stored in contact with the ground. It shall be stored in an enclosed place, in a manner and location that will not cause deterioration of the material. It shall be labeled clearly and numbered to match the Contractor's approved design drawings.
- C. Any damage to the materials and equipment shall be the Contractor's responsibility and all repairs shall be accomplished by the Contractor in accordance with the manufacturer's instructions, at the Contractor's expense.

1.7 SAMPLES

- A. Provide samples of the following proposed items, along with a description of its intended use.

1. All conductor clamps to be used including contact wire clamps.
2. Insulators
3. All other assemblies, fittings, and components as requested by the Engineer

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. OCS assemblies, fittings, and components shall be standard products of manufacturers regularly engaged in the production of such materials and equipment, and shall be the manufacturers' latest proven design.
- B. Contractor shall size all components to meet all site specific loading requirements, in combination with required factors of safety as Specified in SECTION 34 23 10 – OCS Description and General Requirements.
- C. Contractor shall provide components capable of withstanding the project environment without degradation or loss of function.
- D. Products to be purchased shall be identified by the Contractors and quantified in the Bill of Materials Schedule. The Contractor shall make allowances for waste and breakages.
- E. Materials and equipment shall be delivered to the job site in unbroken packages, reels, or other forms of containers.
- F. Materials and equipment shall be stored in a manner that will prevent damage or degradation. Any materials deemed by the Engineer to be damaged shall be replaced at the cost of the Contractor.

2.2 BRACKETS AND HINGES

- A. Brackets, pole wraps, and pole bands with hinges as shown on the Contract Drawings shall be used to attach bracket arms, cross-spans, headspans, cantilevers, pull-offs, and terminations.
- B. The maximum breaking strength, or maximum working strength with corresponding factor of safety of all brackets, pole wraps, and pole bands with hinges shall be shown in shop drawings and catalog cuts.
- C. Contractor shall size all brackets, hinges, and related components as required by loading and Specified component factor of safety, as given in SECTION 34 23 10 – OCS Description and General Requirements.
- D. Specific bracket sizes shall correspond to specific tapered tubular pole sizes.
- E. Brackets that are simple and small, but have the required strength are desirable.

2.3 WIRE PULL-OFF AND BACKBONE ASSEMBLIES

- A. Direct pull-offs shall be suitable for single and multiple track operations.
- B. Pull off and backbone assemblies shall be used to hold the OCS system in its correct alignment on curves.
- C. The Contractor shall design and specify tensions and attachment heights of overhead guying and backbones including bridles and pull offs where required. Contractor shall size all wire, clamps, and components as required by loading and Specified component factor of safety, as given in SECTION 34 23 10 – OCS Description and General Requirements.

- D. Suitable bull-rings may be used in backbone systems to achieve correct tension distribution and accommodate the angles required. If bull-rings are not used, the fittings utilized shall not cause kinking or detrimental stresses in the backbone wire.
- E. Pull-off and Backbone assemblies shall not infringe upon the pantograph envelope.
- F. Stainless Steel wire shall be used for pull off and backbone assemblies.
- G. The pull offs shall be designed to accommodate the loads at each location, and shall maintain a minimum load of 200lb in all locations along the pull off wire at any temperature or condition.

2.4 HEADSPANS

- A. Headspans shall consist of two or more steel span wires with double insulation. The span wires shall include insulators, where required, and turnbuckles with a minimum of 6 inches of adjustment capability, in each direction, after installation.
- B. Contractor shall size all wire, clamps, and components as required by loading and Specified component factor of safety, as given in SECTION 34 23 10 – OCS Description and General Requirements.
- C. Headspan assemblies shall not infringe upon the pantograph envelope.
- D. Headspan geometry shall be in accordance with SECTION 34 23 10 – OCS Description and General Requirements.
- E. Stainless Steel wire shall be used for headspans.

2.5 CROSS-SPANS AND SPAN GUYS

- A. Cross-spans shall consist of a single steel wire with double insulation. Cross-spans and span guys shall be designed for single and multi-track arrangements. The cross-span and span guy wires shall be easily adjustable with turnbuckles to facilitate installation, adjustment, and future maintenance, and shall have at least 6 inches of adjustment in each direction, after installation.
- B. Contractor shall size all wire, clamps, and components as required by loading and Specified component factor of safety, as given in SECTION 34 23 10 – OCS Description and General Requirements.
- C. Cross-span and span guy assemblies shall not infringe upon the pantograph envelope.
- D. Cross-span geometry shall be in accordance with SECTION 34 23 10 – OCS Description and General Requirements.
- E. Stainless Steel Wire shall be used for Crossspans.

2.6 WIRE TERMINATION FITTINGS

- A. Strain type termination assemblies shall be of a straight line design or of other design of aesthetically pleasing appearance.
- B. Wire wrap, cone, or wedge type designs are acceptable, and turnbuckles with a minimum of 6 inches of adjustment capability in each direction after installation shall be included. Slip strength of the assembly shall meet 100% of the breaking strength of the terminating conductor.

2.7 PIPE

- A. Application
1. Pipe is generally used for constructing support assemblies, and can be made from various materials, as Approved by the Engineer.
 2. The cut ends of pipe shall be painted, plugged or capped for protection and appearance.
- B. Standard Sizes
1. ASTM A53 Grade B steel pipes are standard. The following types are commonly used, however the Contractor is responsible for determining appropriate size and schedule of pipe, based on all site specific loadings and structural Specifications provided in SECTION 34 23 10 – OCS Description and General Requirements.
 - a. Steady arms are generally made of ¾ inch diameter schedule 40 or schedule 80 pipes.
 - b. Cantilever frames are generally made of 2 inch diameter schedule 40 or schedule 80 pipes.

2.8 SECTION INSULATORS

- A. Bridging type section insulators shall permit continuous current collection during the passage of a vehicle pantograph, and be suitable for mainline train operations.
1. Bridging section insulators supplied by the contractor shall be Arthur Flury AG type or approved equal.
 2. Section insulators shall be installed in accordance with manufacturer's instructions.
 3. Section insulators shall provide smooth passage of the vehicle pantograph with minimum current interruption by pantographs at running speeds up to 35 mph.
- B. Non-Bridging type section insulators shall ensure that adjacent sections of the OCS will remain electrically isolated from each other during all phases of the passage of a vehicle pantograph.
1. Section insulators shall be installed in accordance with manufacturer's instructions.
 2. Non-bridging section insulators shall provide smooth passage of the vehicle pantograph with minimum current interruption by pantographs at running speeds up to 20 mph.
 3. The non-bridging gap between adjacent electrical sections shall be 18 inches minimum.
- C. All section insulators shall meet or exceed the following design requirements:
1. All Section Insulators will be submitted to the Engineer for Approval.
 2. Test Procedures and Reports, as Specified in SECTION 34 23 80 – OCS Testing, shall be submitted for all Section Insulators.
 3. Section Insulators shall meet the load requirements given in the Contract Drawings with the appropriate factors of safety as Specified in SECTION 34 23 10 – OCS Description and General Requirements.

4. Section Insulators shall meet the electrical requirements Specified for Insulators, in Section 2.12 below.
5. The design shall be suitable for use by new pantograph carbons and by carbons with 1 inch of uneven wear.
6. The design shall ensure that electrical isolation between adjacent electrical sections is maintained at all times.
7. The section insulator shall be designed to remain stable dynamically and structurally, under train operating conditions as specified.
8. The section insulator shall be designed to withstand crosswinds of up to 90 mph without failure or permanent deformation.
9. The design shall ensure that the moving pantograph is continuously in contact with the section insulator.
10. Pantographs drawing current while traversing the section insulator shall not cause excessive arcing or damage to the section insulator or pantograph.
11. The design shall allow for torsional forces resulting from the passage of pantographs at rated speed combined with lateral wind loads.
12. Contact wire skids or runners shall be copper or copper alloy and shall provide a smooth transition from one section to another.

2.9 SURGE ARRESTERS

- A. DC surge arresters shall be outdoor style, intermediate class, and shall be designed, constructed and tested in accordance with the general requirements of ANSI C62.1.1. The arresters shall be rated to withstand normal operating line transients of up to 5000 V DC of either polarity to ground. They shall conduct surges due to lightning strikes, and shall block follow-through current from the substation rectifiers.
- B. Surge arresters shall be submitted to the Engineer for Approval.
- C. Surge arresters shall be of the metal oxide varistor type. Each surge arrester shall have an energy discharge capability of 2.2 kj/kV for currents of 300A or less.
- D. Each surge arrester shall incorporate an individual grounding system which may be connected to a ground rod or ground mat by means of 4/0 AWG copper wire with a 2000 volt rated insulation.
- E. Each surge arrester shall be suitable for mounting directly to OCS poles, and shall be supplied with the required accessories.
- F. Surge arresters shall be installed as shown in the Contract Drawings, in conjunction with these Specifications.
- G. Surge arresters shall be installed at:
 1. Feeder cable termination points at the OCS
 2. Bypass disconnect switch cable terminations at the OCS, on both sides of switch
 3. At locations where the track passes beneath overhead structures

4. At any other locations shown in the sectionalizing diagrams in the Contract Drawings
5. At OCS feed points at the vehicle maintenance facilities

2.10 DISCONNECT SWITCHES

- A. Disconnect switches shall be single or twin, two position, single throw, non-load break, non-grounding, non-fusible air switches with arcing horns.
- B. The disconnect switches shall be capable of breaking load currents under emergency conditions. The switches for the mainline shall be of the exposed type and have a minimum continuous rating of 1500 V DC and 2000 amperes.
- C. The disconnect switch blades and contact surfaces shall be silver-coated copper or copper alloy. The line and load side disconnect terminals shall have silver-plated copper buses complying with ASTM B187, to accommodate the number and size of feeder cables as indicated on the Contract Drawings. The switch terminals shall have provisions for NEMA drilled (2 or 4 hole) cable terminal lugs.
- D. Separate insulated cable strain posts shall be provided for the termination of cables, designed to prevent cable movements from affecting the adjustment of each switch.
- E. Each disconnect switch shall be operated using operating handle near ground level. The operating handle will be included with each disconnect switch.
- F. Disconnect switches shall be suitable for mounting on tapered tubular, ornamental joint use poles.
- G. Disconnect switches shall require approval from the Engineer.

2.11 OCS DOORBRIDGE ASSEMBLY

- A. A special OCS doorbridge assembly is required at each doorway where a roll-up door is installed in a maintenance shop. The roll-up door is typically stored above the lintel of the door, inside the shop.
- B. In order for a roll-up door to close, it is necessary for a short section of the OCS to be retracted out of the path of the door when it closes. The doorbridge provides the means to retract this section of OCS and subsequently, after the door is reopened, to replace the same short section of OCS so the streetcars can enter the shop under their own power with their pantographs raised.
- C. Door bridge assembly includes section insulator for electrical isolation of shop.

2.12 INSULATORS

- A. The Contractor shall prepare detailed designs for each of the required insulators shown on the Contract Drawings. The designs shall be based on the performance requirements, working loads, required factors of safety as Specified in SECTION 34 23 10 – OCS Description and General Requirements, and basic dimensions. The design shall be submitted for review and Approval by the Engineer.
- B. Insulators shall be suitable for the various assemblies including cantilevers, cross-spans, headspans, registration assemblies, terminations, section insulators. and any other strain insulator applications. Insulators shall be furnished complete with integral hardware suitable for connection to supports or OCS hardware.
- C. The insulators metal parts shall be made of malleable iron, ductile iron, or forged steel and shall be galvanized, prior to integration to the body in accordance with ASTM A153.

- D. All adhesives shall be sealed to the fittings to prevent the ingress of moisture.
- E. All insulators shall have a smooth, void free surface. Unless otherwise directed by the Engineer, color shall match Federal Standard 595A color number 36293 (lusterless medium gray). Color shall be submitted to Engineer for Approval. The insulator shall be capable of withstanding service in the climate described in SECTION 34 23 10 – OCS Description and General Requirements
- F. The design of the insulators shall be such that cyclical stresses due to temperature variation, or other loads including torsion due to contact wire roll, shall not lead to insulation deterioration or mechanical failure.
- G. Insulators shall be porcelain or synthetic, as described below.
- H. Porcelain insulators shall be as follows:
 - 1. The insulator shall be made of the best commercial-grade wet process porcelain in accordance with ASTM D116.
 - 2. The insulator surface shall be free of imperfections. Pieces with imperfections in the glaze repaired by recoating and refiring, as well as pieces repaired by re-touching with paint, will be rejected.
- I. Synthetic insulators may be fabricated from any of the following materials or combinations thereof, depending on type or application:
 - 1. Molded ethylene propylene copolymer with hydrated alumina filler
 - 2. Fiberglass-reinforced epoxy solid rod
 - 3. Composite type with molded ethylene propylene copolymer jacket or skirts formed over a fiberglass-reinforced epoxy core
- J. All insulators shall have the following ratings:

Nominal System Voltage	600 V DC
Insulation Level	3.7 kV AC RMS
Creepage Distance	1.88 inch (min)
60 Hz Withstand Voltage, Dry	35 kV
60 Hz Withstand Voltage, Wet	18 kV
- K. Each insulator shall also bear the manufacturer's name or trademark and year of manufacture, clearly and permanently imprinted, without affecting the appearance or function of the insulator.

2.13 OCS FITTINGS AND HARDWARE

- A. OCS fittings and hardware includes the following items which, combined with other major items, completes the total OCS.
 - 1. Clevis fittings
 - 2. Parallel wire and cable clamps
 - 3. Nuts, bolts, and cotter pins
 - 4. Wire terminations

5. Cross-contact assembly
 6. Dead ends
 7. Turnbuckles
 8. Wire splices and connectors
 9. Knuckle assemblies
 10. Links and eyebolts
 11. Thimbles and wire sleeves
- B. All fittings and hardware used for the various OCS assemblies shall be selected and manufactured such that they can be reused after removal.
 - C. All fittings and hardware shall be designed to allow an easy interface with the other components of the OCS system.
 - D. All fittings and hardware shall be designed and installed in a manner which will provide a homogenous OCS hardware and assembly arrangement.
 - E. All components shall be designed such that all fastenings and adjustments are accomplished with the same dimensional standards and tools.
 - F. Clevis fittings, nuts, bolts (excluding bolts securing ground cables), turnbuckles, links, thimbles, and wire sleeves shall be hot dipped galvanized, or stainless steel.
 - G. Cotter pins shall be stainless steel.
 - H. Parallel wire clamps, cable clamps, bolts securing ground cables, wire terminations, dead ends, wire splices, and wire connectors shall be bronze or other copper alloys. Overall OCS design shall ensure the prevention of galvanic corrosion.
 - I. Cross-contact assemblies shall be copper.
 - J. Jumpers shall be double clamped at each end.

2.14 WARNING SIGNS, AND I.D. NUMBERS

- A. Warning signs and pole I.D. numbers shall be supplied and installed by the Contractor.
- B. All signs, and I.D. numbers shall be manufactured for outdoor use. The lettering shall show no appreciable discoloration, cracking, blistering or dimensional changes or loss of adhesion for a period of ten years.
- C. Pole ID Numbers shall be installed on all poles.

PART 3 - EXECUTION

Not Used

PART 4 - MEASUREMENT AND PAYMENT**4.1 MEASUREMENT**

A. The quantities of accepted work will be measured in the following units. All measurements will be plan measure except for authorized changes.

1. Description: Lump Sum

4.2 PAYMENT

A. Payment will be made at the respective unit or lump-sum price listed in the proposal and shall be full compensation for all labor, materials, and equipment necessary to complete the respective unit in place. There will be no separate measurement or payment for any item of work not specifically identified and listed in the proposal, and all such work shall be considered a subsidiary item with all costs pertaining thereto included in the prices for other items listed in the proposal. At the Engineer's option, partial payment may be made for any lump sum item listed in the proposal, providing that the Contractor is diligently and satisfactorily pursuing full completion of such partially complete item in accordance with the approved job progress schedule.

END OF SECTION

SECTION 34 23 64**OCS SPECIAL TOOLS****PART 1 - GENERAL****1.1 SUMMARY**

- A. This Section covers furnishing of all special tools required for the OCS work, including but not limited to, jumpers, assembly-specific slings, hoists, special jig and fabrication tools, compression dies, and any other special tools required for working on the Overhead Contact System.
- B. All special tools specified herein and required by the agency shall be purchased as new for this project in coordination with Engineer. The tools may be used by the Contractor and shall remain his property throughout the construction period of the Overhead Contact System, and during its subsequent testing. All special tools shall become the property of the Owner, and shall be delivered to the Owner in good working condition, as directed and Approved by the Engineer.

1.2 RELATED SECTIONS

- A. DIVISION 01 – General Requirements
- B. SECTION 01 33 00 – Submittal Procedures
- C. SECTION 34 23 66 – OCS Spare Parts
- D. SECTION 34 23 70 – OCS Installation

1.3 SUBMITTALS

- A. Submittals shall be made in accordance with the requirements of SECTION 01 33 00 – Submittal Procedures, except as modified herein.
- B. Shop drawings and manufacturer catalog cuts shall be submitted showing details and dimensions of all special tools, together with complete specifications of materials proposed for components. The Contractor shall verify the capacity of the tools specified to suit the construction and maintenance needs, and submit their proposal for complete list of tools and tackle for this project for Approval of the Engineer, before procurement.

PART 2 - PRODUCTS**2.1 MATERIALS**

- A. All special tools proposed for use shall meet the applicable performance requirements, and shall be non-corroding and durable.

2.2 MANUFACTURED ITEMS

- A. The Contractor shall furnish the following general types of OCS special tools, and manufactured items to the agency, prior to procurement:
 - 1. Manufacturer specific tools (installation, adjustment, maintenance) – two each
 - 2. Shop fabrication jigs (jumpers, and cross contact bridges) – two each
 - 3. Cable thimble, compression and crimp dies and tools – three each

4. Special fastener keys and sockets – three each
 5. Safety tools provided with equipment from manufacturers – two each
 6. Go/No-Go gauges supplied by manufacturers – two each
 7. Optical Stagger Gauges – two each
 8. Other specialized OCS tools required to install, align, test and commission the catenary and/or components and assemblies – two each
- B. The above special tools are the typical style/purpose tools to be furnished to the Owner. The Contractor shall provide any other special tools required for the installation and maintenance of any other specialized OCS components.
- C. This requirement shall not restrict the Contractor from selecting and providing all necessary tools and equipment to be used by his own crews for the OCS construction.

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

- A. The OCS Contractor shall deliver all special tools and products to a location designated by the Engineer, complete and ready for use, subject to the inspection of the Engineer, in sufficient time for all required OCS adjustment purposes.
- B. The OCS Contractor shall be responsible for and protect all products from damage during the duration of the project and shall deliver all special tool items in good working condition to the Owner at the completion of the project. All special tools and equipment required by this Specification that are damaged and rendered useless for this intended purpose, or lost or stolen during the execution of this Contract, shall be replaced by the Contractor at the Contractor's expense.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

- A. The quantities of accepted work will be measured in the following units. All measurements will be plan measure except for authorized changes.
1. Description: Lump Sum

4.2 PAYMENT

- A. Payment will be made at the respective unit or lump-sum price listed in the proposal and shall be full compensation for all labor, materials, and equipment necessary to complete the respective unit in place. There will be no separate measurement or payment for any item of work not specifically identified and listed in the proposal, and all such work shall be considered a subsidiary item with all costs pertaining thereto included in the prices for other items listed in the proposal. At the Engineer's option, partial payment may be made for any lump sum item listed in the proposal, providing that the Contractor is diligently and satisfactorily pursuing full completion of such partially complete item in accordance with the approved job progress schedule.

END OF SECTION

SECTION 34 23 66**OCS SPARE PARTS****PART 1 - GENERAL****1.1 SUMMARY**

- A. This Section includes the requirements for OCS mandatory spare parts for the KCMO Streetcar project.
- B. Owner may elect to purchase additional spares separately.

1.2 RELATED SECTIONS

- A. SECTION 01 33 00 – Submittal Procedures
- B. SECTION 01 43 00 – Systems Quality Assurance

1.3 QUALITY ASSURANCE

- A. OCS spare parts shall comply with the requirements of all applicable OCS Specification Sections and shall be in accordance with SECTION 01 43 00 – Systems Quality Assurance except where modified within this Specification section.

1.4 SUBMITTALS

- A. Unless otherwise specified, all submittals shall be in accordance with SECTION 01 33 00 – Submittal Procedures.
- B. Submit a detailed Mandatory Spare Parts list with part numbers, manufacturer, and cost for the Approval of the Engineer as part of the Project Shop Drawing and Submittals procedures.
- C. Submit detailed Recommended Spare Parts list with part numbers, manufacturer, and cost for the approval of the Engineer as part of the project shop drawing and submittal procedures.

PART 2 - PRODUCTS**2.1 GENERAL**

- A. Provide the following items to be bid as part of this Contract.
 - 1. All provisioning items shall be identical to the project approved/installed items and shall meet all requirements of the appropriate Sections of these Specifications. Parts availability from the approved supplier to the agency shall be for a period of not less than 7 years after the end of this Contract.
 - 2. All items shall be complete and ready for installation, except for wire or cable and that necessary for connections.

2.2 SPARE PARTS

A. The following mandatory spare parts shall be furnished as part of the OCS Contract:

1	Cantilever Assemblies (complete assemblies)	
	Push-Off – direct suspension light load	1 Each
	Pull-Off – direct suspension light load	1 Each
	Push-Off – heavy load	1 Each
	Pull-Off – heavy load	1 Each
2.	Cantilever Components	
	Steady Arms – light load	2 Each
	Steady Arms – heavy load	2 Each
3	Section Insulator (bridging)	1 Each
4	Section Insulator (non-bridging)	1 Each
5	Surge Arresters (with mounting hardware)	5 Each
6	Pole mounted disconnect switch (assembly)	2 Each
7	In-Span Contact Wire Insulators and Fittings	4 Each Type
8	Termination Turnbuckles	2 Each
9	Pole Bracket Assemblies	2 Each Type
10	Contact Wire Bridge Assemblies	2 Each
11	Poles	4 (Type and length to be determined by the Engineer)
12	Ornamental Poles	4 (Type and length to be determined by the Engineer)
13	Contact Wire	1 Drum (5000 feet minimum)
14	Cable (structural)	500 feet of each type of cable used to support OCS
15	Cable (feeder)	500 feet of each type used to electrically feed OCS

B. Special Tools and Equipment – Provide special tools and equipment as needed for installation, adjustment and testing as specified in SECTION 34 23 64 – OCS Special Tools.

PART 3 - EXECUTION**3.1 DELIVERY**

- A. Deliver all spare parts to a location directed by the Engineer. Pack all material for warehouse storage and clearly mark with manufacturer's part and/or style number.
- B. Unload and store all items neatly in the Owner's storage facility as directed by the Engineer.
- C. Complete delivery and storage for all spare parts prior to OCS commissioning.

3.2 WARRANTY USE

- A. In the event that any initial provisioning spare part items must be used in the course of satisfying the OCS Contract warranty procedures, the Contractor shall replace such items at the Contractor's expense.

PART 4 - MEASUREMENT AND PAYMENT**4.1 MEASUREMENT**

- A. The quantities of accepted work will be measured in the following units. All measurements will be plan measure except for authorized changes.
 - 1. Description: Lump Sum

4.2 PAYMENT

- A. Payment will be made at the respective unit or lump-sum price listed in the proposal and shall be full compensation for all labor, materials, and equipment necessary to complete the respective unit in place. There will be no separate measurement or payment for any item of work not specifically identified and listed in the proposal, and all such work shall be considered a subsidiary item with all costs pertaining thereto included in the prices for other items listed in the proposal. At the Engineer's option, partial payment may be made for any lump sum item listed in the proposal, providing that the Contractor is diligently and satisfactorily pursuing full completion of such partially complete item in accordance with the approved job progress schedule.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 34 23 70

OCS INSTALLATION

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section covers installation of the OCS as described in SECTION 34 23 10 – OCS Description and General Requirements.
- B. Work under this Section includes the assembly and installation of OCS wiring equipment and fittings in accordance with the OCS Wiring Layout Drawings, OCS Assembly Drawings, and related drawings contained in the Contract Drawings, and Specifications.
- C. The equipment to be installed includes OCS supports, conductors, feeder jumpers, terminations, sectioning equipment, and all other OCS associated components to create an OCS suitable for streetcar operations in public streets.
- D. All OCS equipment is energized at a nominal 750 V DC, and shall be double insulated. A minimum of two levels of electrical insulation separated by a minimum distance of 4 feet shall be provided between the contact wire and an OCS pole or other grounded structure.
- E. Installation of OCS material shall be part of the coordinated work plan for the complete project. The Contractor shall be required to submit Procedures and Plans for all stages of work for Approval by the Engineer. Approval shall not relieve the Contractor from liability for damages incurred during installation of the OCS.

1.2 RELATED SECTIONS

- A. DIVISION 01 – General Requirements
- B. SECTION 01 33 00 – Submittal Procedures
- C. SECTION 01 43 00 – Systems Quality Assurance
- D. SECTION 26 – Traction Power Specifications
- E. SECTION 34 23 10 – OCS Description and General Requirements
- F. SECTION 34 23 35.99 – OCS Pole Painting
- G. SECTION 34 23 37 – OCS Tubular Steel Poles
- H. SECTION 34 23 37.11 – OCS Pole Ornamentation
- I. SECTION 34 23 40 – OCS Wire and Cable
- J. SECTION 34 23 50 – OCS Assemblies, Components, and Fittings
- K. SECTION 34 23 77 – OCS Surge Arrester Installation
- L. SECTION 34 23 78 – OCS Disconnect Switch Installation
- M. SECTION 34 23 80 – OCS Testing

1.3 SUBMITTALS

- A. Submittals shall be made in accordance with the requirements of SECTION 01 33 00 – Submittal Procedures of the Contract Documents, except as modified herein.
- B. OCS installation procedures:
 - 1. Submit procedures for all stages of OCS installation, including pole installation, cantilever framing and installation, headspan installation, bridle and pulloff installation, conductor stringing (including pre-tensioning and final tensioning methods), insulation cut-in, disconnect switch installation, and any other OCS installation activities. Procedures shall be Approved by the Engineer prior to commencement of the Work.
 - 2. Submit staging plans providing the sequence of the Work, including methods of securing the Work during periods of interruption. Staging plans shall be Approved by the Engineer prior to commencement of the Work.
 - 3. Submit manufacturers data and usage procedures for tools used to grip contact wire during stringing and where held under tension. The Contractor shall use a grip method that does not produce a kink in the Contact Wire. Contact Wire kinks will not be accepted, without exception. The method of gripping shall be submitted to the Engineer for Approval, however Approval will not release the Contractor from liability if the method produces kinks in the Contact Wire.
 - 4. Submit a schedule of OCS fabrication and installation activities to the Engineer on a weekly basis. Deviation from the schedule shall be reported to the Engineer on a daily basis.
 - 5. Submit the updated conductor erection spreadsheet within five (5) days of the installation of each conductor length. Information on the spreadsheet shall include wire run number, length, pre-tension load, pre-tension temperature, duration of pre-tensioning, final tension load, final tension temperature, and notes describing any unusual circumstances.
 - 6. Submit a schedule of pole stationing labels showing pole identification (ID) numbers, and warning signs for pre-approval before proceeding with their procurement or installation.

1.4 QUALITY ASSURANCE/QUALITY CONTROL

- A. Quality Control/Quality Assurance shall be in accordance with SECTION 01 43 00 – Systems Quality Assurance except where modified within this specification section.

1.5 SAFETY REQUIREMENTS

- A. The health and safety of workers and the public shall be in accordance with applicable state and federal regulations, in conjunction with the project Specifications.

1.6 HANDLING

- A. OCS assembly, component, and fittings materials shall be packaged, handled, and transported to site in a manner that will prevent damage occurring to the material and any surface coatings.
- B. OCS Material shall not be stored in contact with the ground. It shall be stored in a manner and location that will not cause deterioration of the material.
- C. Materials delivered to site shall only be stockpiled in areas specified in the Construction Plan and Approved by the Engineer.

- D. Any damage to the materials and equipment shall be the Contractor's responsibility and all repairs shall be accomplished by the Contractor in accordance with the manufacturer's instructions, at the Contractor's expense.

1.7 LICENSING AND CERTIFICATION REQUIREMENTS

- A. All Work specified in this Section shall be performed by workers skilled and experienced in the installation of OCS systems.
- B. Superintendent Qualifications
 - 1. The OCS superintendent shall demonstrate previous superintendent experience in successfully performing Work of this type on a project of similar size and complexity. Experience shall include the supervision and training of OCS installation crew, as well as interpretation of OCS specifications, design drawings, OCS equipment manuals, and OCS manufacturer's design drawings.
- C. OCS Installation Crew Foreman Qualifications
 - 1. A foreman shall be appointed for each crew not exceeding six OCS installers, or where crews work independently. The foreman shall have demonstrated experience or training in the installation of OCS, and demonstrated experience as foreman of OCS installations or similar overhead line work.
- D. OCS Installer Qualifications
 - 1. OCS installers shall be qualified by experience and training to perform the specified work. A Journeyman Lineman shall have completed a federally approved Outside Line Construction and Maintenance apprenticeship program.

1.8 TOOLS

- A. Contact wire shall only be strung or held in tension by specifically designed grips that pull along the wire centerline without bending or kinking the wire.
- B. Tools that are deformed or otherwise damaged shall be discarded and replaced at the Contractor's expense.
- C. Fittings and equipment designed for permanent installation shall not be used as multiple use construction tools.

PART 2 - PRODUCTS

2.1 OCS SHOP DRAWINGS

- A. Shop drawings shall be submitted in accordance with SECTION 01 33 00 – Submittal Procedures and all related OCS Specifications.
- B. Shop drawings shall be prepared by the contractor to demonstrate the form, fit and function of each assembly reference given in the Contract Drawings, and be assigned the same assembly reference and assembly description.
- C. Shop drawings shall assign the full technical description of any pipe, wire or cable used in the detailed assembly.
- D. Shop drawings shall show the maximum rated strength and corresponding factor of safety of each assembly as appropriate.
- E. Shop drawings shall be specifically designed for use on this project and submitted for approval and approved by the Engineer prior to procurement of materials.

- F. Each shop drawing shall be supported by component drawings and/or catalog cuts as appropriate.
- G. Shop drawings shall be supported by appropriate index sheets of both assembly references and of components numbers.

2.2 CONTACT WIRE

- A. Contact wire shall be supplied in accordance with SECTION 34 23 40 – OCS Wire and Cable.

2.3 JUMPERS

- A. Insulated and bare jumpers shall be fitted with flexible jumper wire in accordance with SECTION 34 23 40 – OCS Wire and Cable, and configured as shown in OCS Contract Drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. The following describes the Work required for the installation of the assemblies, wiring, and fittings of the complete OCS system onto poles erected as specified in SECTION 34 23 72 – OCS Tubular Pole Installation.
- B. The Work shall also include design verification, stringing, tensioning, supporting, registering, and anchoring the conductors, installing jumpers, section insulators, disconnect switches, surge arresters, and other ancillary equipment and hardware, including contact wire bridges and other components, as required, to provide a complete and fully operational OCS.
- C. The Contractor shall be responsible for coordinating the OCS installation with other project civil, structural, systems, and electrical work.
- D. The Contractor shall submit, for review and approval by the Engineer, drawings for all temporary anchorages, guying, and electrical isolations.
- E. Fasteners shall include bolts, nuts, locknuts, washers, pins, turnbuckles, machine screws and other items that may be used to attach items together. Fasteners shall be installed in accordance with the manufacturer's recommendations. Bolts shall be of sufficient length to allow two full threads to extend beyond the nuts and locknuts; however, the end of the bolt must never extend more than 1.5 inches beyond the nut or locknut. Threads of all bolts, nuts and machine screws shall be lightly lubricated prior to assembly, and shall be torqued using a calibrated torque wrench in accordance with the manufacturer recommendations. Fittings, fasteners, or any other attachments that do not fit, are cracked, have sustained galvanizing damage during installation, or are found to be defective in any way, shall be rejected and replaced at the Contractor's expense. Contractor shall install hardware such that the orientation of nuts, bolts, and pins is consistent to the extent possible.
- F. Drilling, cutting, or reaming of components will not be permitted without prior Approval of the Engineer.
- G. Turnbuckles, where used, shall be installed in a manner that will provide 50% of the available take-up and release, to remain for future adjustment.
- H. At all stages of work, Contact Wire is to be handled with special care to prevent bending, kinking, twisting or other forms of damage. Wire grips and other installation equipment shall be designed and used so as not to damage or bend the wire. Kinks in the Contact Wire will not be accepted under any circumstances.

3.2 INSTALLATION TOLERANCES

- A. The installed OCS shall conform to the dimensional requirements shown on the Contract Drawings and shop drawings, within the following tolerances:
1. Pole rake at pole top (after loading at 60 degrees Fahrenheit) – 1 inch off vertical
 2. Contact wire height:
 - a. At support 1 inch
 - b. At a bridge 0.5 inch
 3. Contact wire stagger at registration 1 inch
 4. Wire tension 50 lb

3.3 OCS ASSEMBLIES

- A. OCS support and termination assemblies, and all other defined and described OCS assemblies shall be constructed in accordance with approved shop drawings to the dimensions shown in the Contract Drawings.
- B. All OCS dimensioning shall be to the centerline of the track rails in the plane of the rail surfaces or as shown in the Contract Drawings.
- C. Prior to conductor stringing all installed supports and termination assemblies shall be restrained against movement by the wind and weather. In particular, cantilevers shall not be allowed to swing in the wind. Any materials damaged by inclement weather shall be discarded and replaced at the Contractor's expense.

3.4 CONTACT WIRE STRINGING

- A. Contact wire shall be installed in accordance with the Contractor's procedure, as approved by the Engineer. Allowance shall be made for conductor creep.
- B. In order to reduce creep, the Contractor shall pre-stress the contact wires while in temporary rollers or travelers for a minimum period of 48 hours prior to any clamping or clipping in at supports.
- C. Contractor shall submit the pre-stressing procedure to the Engineer for Approval, prior to commencement of stringing. The procedure shall describe the proposed method including:
1. The pre-stress tension and pre-stress time period to be applied to the contact wire before being reduced to normal tension and adjusted to its final position, and clipped in
 2. The Contractor's check of the adequacy of the OCS structures and supports to ensure that they can safely carry any proposed loading in excess of the design values

- D. During final stringing, actual conductor temperature, as measured by contact thermometers, shall be used in conjunction with the conductor erection tables provided in the Contract documents to ascertain the various stringing parameters. The actual erection tension shall be based on conductor temperature and equivalent span. The climatic and span data shall be entered on a conductor erection spreadsheet developed by the Contractor, and shall be used to ensure conformity to the actual wire data before contact wire stringing is started. The conductor erection spreadsheet developed by the Contractor shall be updated and submitted to the Engineer within 5 days of the installation of each contact wire.
- E. The contact wire shall be attached to the anchor and strung out, being held in its approximate lateral position in relation to the track centerline by the use of temporary rollers at supports to prevent kinking. Rollers used by the Contractor shall not create kinks in the Contact Wire. The contact wire shall be strung under a tension adequate to keep the contact wire from touching the ground during stringing. After stringing, the contact wire shall be pre-stressed as described above before it is reduced to the contact wire tension for the ambient temperature, and the steady arms or other registrations attached, removing any twists in the contact wire by working from one anchor to the other. Wire pull-offs shall then be installed and tensioned.
- F. After final tensioning has been completed, cross-spans, cantilevers, and pull-offs shall be set normal to the track, and the contact wire heights and staggers adjusted as required to obtain the values given in the wiring layout drawings and wire schedule drawings.

3.5 CONDUCTOR SPLICES

- A. Splices shall not be installed in the in-running contact wires, without exception. At locations where the Contact Wire is out of running, splices may only be used with approval from the Engineer. Splices shall be positioned so as not to interfere with the operation of other wires, fittings or equipment under all climatic and operating conditions.

3.6 JUMPERS

- A. Continuity jumpers and feeder jumpers shall be erected where shown on the OCS layout drawings and shall be installed in accordance with the manufacturer's recommendations. The Contractor shall determine the lengths of the jumpers, based on actual field measurements, and the jumpers shall be installed, secured and shaped to avoid conflicts with the uplifted pantographs and so as to not restrict minor movement of adjacent cantilevers. Jumper wire shall have cut and tied ends that shall not project more than 1 inch through the connection clamps.
- B. Connection clamps shall be installed as in accordance with manufacturer's recommendations. Before fitting the connector clamps, the conductors shall be cleaned and wire-brushed to ensure a good electrical connection beneath the clamp, and shall be lubricated with a conductive grease as recommended by the manufacturer. The connector bolts shall be torqued to the manufacturer's recommendations using a calibrated torque wrench.
- C. Feeder cables shall be double clamped.
- D. Feeder jumpers shall be connected to the cantilever pipes and cross-spans by means of insulated clamps or clips

3.7 CONTACT WIRE BRIDGES

- A. Contact wire bridges shall be used for crossing of contact wires in crossovers and other areas where in running contact wires cross each other as shown on the layout drawings.
- B. Contact wire bridges shall be double clamped at each end.

- C. Contact wire bridges shall be installed at crossed contact wire locations shown on the layout drawings.
- D. The contact wire bridges shall allow some free movement of the contact wires over the operating temperature range. A minimum contact wire bridge length of 2 feet shall be used. The upper contact wire shall be adjusted to float through the contact bridge assembly under normal conditions with no pantograph uplift.

3.8 SECTION INSULATORS

- A. Section insulators shall not be cut into a contact wire until the adjustments of Section 3.4 have been completed and the contact wire is ready for final tensioning.
- B. Section insulators shall be located as shown on the contract drawings and only installed after the Engineer has given his approval to each site-specific location in the field.
- C. Section insulators shall be installed in accordance with the manufacturer's recommendations.
- D. Each section insulator shall be installed and adjusted to provide a smooth passage for the pantograph without causing rocking or arcing. The section insulator shall be free to move without twisting or becoming misaligned.
- E. Section insulators shall be installed in straight running contact wire, without deviation at the Section Insulator.
- F. All electrical connectors and clamps shall be prepared and protected externally and internally in accordance with the manufacturer's recommendations.
- G. Extreme care shall be taken during installation of section insulators and related components, to prevent the contact wire from being damaged. Any damage to the contact wire shall be repaired or replaced at the Contractor's expense.

3.9 SURGE ARRESTERS

- A. Install surge arresters per SECTION 34 23 77 – OCS Surge Arrester Installation, of these Specifications.

3.10 DISCONNECT SWITCHES

- A. Install disconnect switches per SECTION 34 23 78 – OCS Disconnect Switch Installation, of these Specifications.

3.11 WARNING SIGNS AND POLE IDENTIFICATION NUMBERS

- A. Warning signs shall be installed at the following locations:
 - 1. Method of attachment of signs shall be Approved by the Engineer. At locations where method proves inadequate the Contractor shall design a different method of attachment for Approval. Any signs needing a new method of attachment will be replaced at the Contractor's expense.
 - 2. "Danger High Voltage" – On each pole in station platform areas and on each pole to which a switch operating handle is installed.
 - 3. The Contractor shall prepare a schedule of locations for warning signs for approval by the Engineer.
 - 4. Warning signs shall be installed on all poles at a height and orientation site specifically agreed by the Engineer.

5. Pole I.D. numbers shall be installed on all OCS poles, with site specific exclusion being Approved by the Engineer.
6. The Contractor shall prepare a schedule of locations for pole I.D. numbers for approval by the Engineer.
7. Pole I.D. numbers shall be installed on all poles at a height and orientation site specifically agreed by the Engineer.

3.12 POLE GROUNDING

- A. Grounding and Bonding shall be performed in accordance with the Contract Drawings and Specifications, and the National Electric Code (NEC).
- B. On each pole where a surge arrester is installed, a 2/0 insulated ground wire from the surge arrester shall be exothermically welded to the top of the lightning arrester ground rod. The surge arrester cable shall be a single piece of wire, with no splices or interruptions. If multiple lightning arresters are required, they shall each have their own ground rod and ground wire. OCS Contractor shall coordinate this work with all other Project Work.
- C. On each pole without a surge arrester, a 2/0 insulated pole ground wire shall be exothermically welded to the top of the foundation ground rod. The final connection of the 2/0 ground wire shall be made with compression connectors bolted to a grounded stud or tag provided for that purpose inside the pole. OCS Contractor shall coordinate this work with all other Project Work.
- D. Where exothermic welds are to be made to a galvanized surface, galvanizing shall be removed using a grinding wheel to expose a clean surface. After welding, repair the galvanized coating on the steel surface using an Approved zinc rich cold galvanizing paint, ZRC Cold Galvanizing Compound, or an Approved equal. Surface preparation and application of the galvanizing repair shall be in accordance with the repair material manufacturer's recommendations.
- E. Exothermic welding cartridges and molds shall be for the type of weld shown on the Contract Drawings, and be performed in accordance with the manufacturer's recommendations. Worn and damaged molds shall be discarded and not used. Where directed by the Engineer, welds and molds shall be replaced.

3.13 REPAIRS

- A. Repairs to any part of the OCS shall only be made as approved by the Engineer. Damaged components shall be removed from site, or reported to the Engineer along with a proposed repair procedure. The Engineer shall determine if components shall be discarded and replaced at the Contractor's expense.
- B. Any insulator damaged or degraded in any way shall be replaced at the Contractor's expense, without exception.
- C. Vertical kinks in the contact wire shall be removed using a power operated tool or by hand using a leather or copper faced hammer to beat the contact wire against a flat smooth surface such as a hardwood block.
- D. Lateral kinks in the contact wire shall be removed if they affect the fit of any parts or are detrimental to pantograph operation. Twists in the contact wire shall be corrected.
- E. No contact wire kinks will be accepted in the final product, without exception.

- F. Damage to the galvanizing of poles, assemblies, components and hardware shall be repaired by the application of an Approved zinc-rich, cold galvanizing repair paint, ZRC Cold Galvanizing Compound, or an Approved equal. Surface preparation and application of the galvanizing repair shall be in accordance with the repair material manufacturer's recommendations.
- G. All Work associated with touch-up painting and grouting will be at the Contractor's expense.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

- A. The quantities of accepted work will be measured in the following units. All measurements will be plan measure except for authorized changes.
 - 1. Description: Lump Sum

4.2 PAYMENT

- A. Payment will be made at the respective unit or lump-sum price listed in the proposal and shall be full compensation for all labor, materials, and equipment necessary to complete the respective unit in place. There will be no separate measurement or payment for any item of work not specifically identified and listed in the proposal, and all such work shall be considered a subsidiary item with all costs pertaining thereto included in the prices for other items listed in the proposal. At the Engineer's option, partial payment may be made for any lump sum item listed in the proposal, providing that the Contractor is diligently and satisfactorily pursuing full completion of such partially complete item in accordance with the approved job progress schedule.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 34 32 71**OCS POLE FOUNDATIONS****PART 1 - GENERAL****1.1 SUMMARY**

- A. The Work covered by this Specification shall include the furnishing of all labor, equipment, tools, services and materials for complete and proper installation of Overhead Contact System (OCS) pole foundations as indicated on the plans.
- B. The work to be performed under this specification shall include all surveying and field layouts necessary for the correct location of the pier foundations. This includes walkout survey of OCS pole placement by the OCS Contractor.
- C. Provide and install steel reinforcement, anchoring and grounding devices within the foundations.
- D. Excavate the foundations, furnish all cast-in-place concrete foundations.
- E. Clean up the work areas after completion of each foundation, including disposal of all refuse.

1.2 RELATED SECTIONS:

- A. DIVISION 01 – General Requirements
- B. SECTION 01 33 00 – Submittal Procedures
- C. SECTION 34 23 10 – OCS Description and General Requirements
- D. SECTION 26 Systemwide Electrical Specifications
- E. SECTION 34 23 70 – OCS Installation
- F. SECTION 34 23 77 – OCS Surge Arrester Installation
- G. SECTION 34 23 78 – OCS Disconnect Switch Installation
- H. SECTION 34 23 80 – OCS Testing
- I. MISSOURI DEPARTMENT OF TRANSPORTATION GOVERNING SPECIFICATIONS AND SPECIAL PROVISIONS, AS LISTED IN KCMO STREETCAR PROJECT TECHNICAL SPECIFICATIONS

1.3 REFERENCES

- | | | | |
|----|------|-------|---|
| A. | ASTM | A36 | Structural Steel |
| B. | ASTM | A123 | Zinc Coating (Hot-Dip Galvanized) on Iron and Steel Products |
| C. | ASTM | A153 | Zinc Coating (Hot-Dip) on Iron and Steel Hardware |
| D. | ASTM | A252 | Welded and Seamless Steel Pipe |
| E. | ASTM | A615 | Deformed and Plain Billet-Steel Bars for Concrete Reinforcement |
| F. | ASTM | F1554 | Standard Specification for Anchor Bolts |

G.	ACI	ACI-305	Recommended Practice for Hot Weather Concreting
H.	ACI	ACI-306	Recommended Practice for Cold Weather Concreting
I.	AASHTO	M-232	Specification for Zinc Coating (Hot-Dip Galvanized) on Iron and Steel Hardware
J.	AASHTO	M-291	Specification for Carbon and Steel Nuts
K.	AASHTO	M-293	Specification for Hardened Steel Washer
L.	AASHTO	M-342	Specification for Steel Bolts and Studs
M.	AWS	D1.1	Structural Welding Code – Steel

1.4 SUBMITTAL

- A. Submit the following for approval in accordance with SECTION 01 33 00 – Submittal Procedures under the General Requirements.
 - 1. Shop Drawings
 - 2. Certificates and Test Reports
 - 3. Written description of construction procedures, material used, Product Data and equipment for drilling the foundation

1.5 QUALITY ASSURANCE

- A. Contractor shall employ sufficient personnel skilled and experienced to properly perform the work of this section, and shall use adequate equipment.
- B. Contractor shall perform the following in accordance with the requirements of the Contractor's Quality Control Program as approved by the Engineer.
 - 1. Material qualification testing and mill certification for acceptance
 - 2. Job control testing of in-progress work in shops and continuous field inspection
- C. Installation of ground rods and other electrical material shall be by licensed Electricians, registered in the State of Missouri.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Materials shall be delivered to the site in undamaged condition and stored off the ground in a well drained location, protected from damage, and easily accessible for inspection and handling.

1.7 PROJECT CONDITIONS

- A. Comply with ACI 305 and 306 during hot and cold weather conditions.

PART 2 - PRODUCTS

2.1 MANUFACTURERS AND MATERIALS

- A. Temporary Casing Shell: Steel casing shall have an outside diameter equal to or greater than the specified diameter of the drilled shaft, and shall have sufficient strength to withstand handling stresses, concrete pressure, and surrounding earth or fluid pressures.

1. Concrete:
 - a. As specified in MISSOURI DEPARTMENT OF TRANSPORTATION GOVERNING SPECIFICATIONS AND SPECIAL PROVISIONS, AS LISTED IN KCMO STREETCAR PROJECT TECHNICAL SPECIFICATIONS except as modified herein.
 - b. Concrete shall have a minimum compressive strength of 3600 psi at twenty-eight days.
- B. Reinforcement:
 1. As specified in MISSOURI DEPARTMENT OF TRANSPORTATION GOVERNING SPECIFICATIONS AND SPECIAL PROVISIONS, AS LISTED IN KCMO STREETCAR PROJECT TECHNICAL SPECIFICATIONS except as modified herein.
- C. Anchor Bolts:
 1. As specified in MISSOURI DEPARTMENT OF TRANSPORTATION GOVERNING SPECIFICATIONS AND SPECIAL PROVISIONS, AS LISTED IN KCMO STREETCAR PROJECT TECHNICAL SPECIFICATIONS except as modified herein.
 - a. F1554 Anchor bolts, 55Ksi
- D. Concrete Formwork:
 1. Refer to MISSOURI DEPARTMENT OF TRANSPORTATION GOVERNING SPECIFICATIONS AND SPECIAL PROVISIONS, AS LISTED IN KCMO STREETCAR PROJECT TECHNICAL SPECIFICATIONS and as specified below.
 2. Forms used in constructing pier above ground level shall be of sufficient strength to withstand the pressure of concrete and shall provide concrete having smooth surface.
- E. OCS Pole Grounding
 1. OCS Foundations shall include pole grounding installation as shown in the Contract Drawings and described in the Specifications.
 2. OCS foundations at locations with surge arresters shall include surge arrester grounding installation as shown in the Contract Drawings and described in the Specifications.
 3. Grounding rods shall be in accordance with Systemwide Electrical Specification.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Walkout Survey: After the Contractor has established the location of pole foundations, and prior to starting excavation, a walkout survey shall be conducted by representatives of Engineer and the Contractor, and any other parties affected by foundation locations, in order to resolve any problems resulting from pole placement in the indicated location.

3.2 EXCAVATION/ERECTION/APPLICATION

- A. Drill the pier shafts at locations and to the dimensions and depths as indicated on the plans and control them within the specified tolerances.

- B. Abandoned pipe, concrete, boulders and other obstructions, which extend into the pier shafts and prevent the proper formation of piers shall be removed. The permanent utility lines and piping which are interfered with by the pier shafts shall be brought to the Engineer's attention.
- C. Blasting shall not be permitted for use on OCS pole foundations.
- D. Excavated drilling materials that are surplus, or do not comply with the reusable materials as specified, shall be removed from job-site and disposed of as directed.
- E. Steel casing shells shall be used, where required by the Engineer to control ingress of water or prevent caving of the pier shaft.
- F. Reinforcing steel, anchor bolts shall be installed as follows:
 - 1. Place the reinforcement and install the anchor bolts, and grounding plates or rods in the foundations. Reinforcement shall not be spliced.
 - 2. The reinforcing cage shall be placed symmetrically about the axis of foundations, and shall be securely braced to maintain the minimum clearance of concrete cover as indicated. Maintain in clean condition until embedded in concrete.
 - 3. The anchor bolt assemblies, grounding plates and rods shall be located and oriented as indicated, with the specified tolerances.
 - 4. Prefabricated templates shall be used to hold the projecting portion of the anchor bolts in their proper positions.
- G. Remove all loose material from the bottom of the drilled shafts and dewater as required prior to and during placing of concrete.
- H. Immediately after approval of the reinforcement and anchor bolts installation by the Engineer begin the placement of the concrete. Concrete shall be placed in one continuous operation in each pier shaft.
- I. To prevent segregation of concrete, place concrete by tube or tremie method.
- J. Excavation, installation of reinforcement and anchor bolts, and concreting of the foundation shall be scheduled so that each drilled shaft is poured within twelve hours after excavation. The number of foundations left open at the end of a work day shall be kept to a minimum and shall be adequately covered and protected against possible hazards.
- K. Wherever steel casing shells are used, they shall be withdrawn as the concrete is placed. An adequate head of concrete shall be maintained above the bottom of the casing to resist the soil and water pressures.
- L. The anchor bolt template may be removed from a pier and reused elsewhere two days after the concrete has been placed.
- M. All exposed, rough concrete surface shall be steel troweled to produce a smooth, dense surface. Pier top shall be finished with 1% slope, as indicated on the Contract plans.
- N. OCS pole and surge arrester grounds shall be tested in accordance with SECTION 34 23 80 – OCS Testing.
- O. Conduit sleeves for feeder cables, lighting cables, lightning arrester cables, traffic signals, and any other amenities shall be verified and installed prior to pouring foundation concrete.

3.3 FIELD QUALITY CONTROL

A. Allowable Tolerances:

1. Allowable OCS foundation construction tolerances shall be in accordance with MISSOURI DEPARTMENT OF TRANSPORTATION GOVERNING SPECIFICATIONS AND SPECIAL PROVISIONS, AS LISTED IN KCMO STREETCAR PROJECT TECHNICAL SPECIFICATIONS, except as modified herein.
2. Each pier foundation shall be located within 2 inches of its offset dimension, as indicated on the foundation plans or as approved by the Engineer.
3. To avoid local obstructions the along-track positions of pier foundation indicated may be modified by up to ± 5 feet. Adjacent to special trackwork or curved track of a 500 foot radius or less, the along-track positions of the OCS pole foundation can only be modified by up to ± 2 feet. Such modifications are subject to prior approval by the Engineer.
4. Axis of the shaft shall not be out of plumb more than 1% of its excavated depth.
5. Each pier foundation shall not be less than the correct diameter and length indicated on the plans.
6. Each anchor bolt shall be located within 1/8 inch of its correct horizontal position and 1/2 degree of true vertical in its anchor bolt assembly, as indicated on the plans.
7. Anchor bolt assembly shall be located within 1-1/2 inches of its correct offset dimension and vertical position, as indicated in the plans. The anchor bolt positions shall be determined relative to the offset dimensions from the vertical and horizontal base lines, or track center line.
8. Each anchor bolt assembly shall be located within two degrees of its correct orientation, as indicated on the plans.
9. The top of concrete of each foundation shall be within 1/4 inch of its correct elevation, as indicated on the plans.

3.4 ADJUSTING AND CLEANING

- A. Notify the Engineer after installation of the reinforcement, anchor bolt assembly in each foundation that the installation is ready for inspection. Adjust the reinforcement, anchor bolts as required by the Engineer.
- B. At the conclusion of the foundation work, remove equipment used in the work, and remove all debris, surplus material, and excavated soil from the site.

3.5 PROTECTION

- A. Open pier shafts and incomplete construction shall be covered to prevent hazards.
- B. Protect projecting and exposed surfaces from injury during entire construction period.
- C. The anchor bolts shall be protected from damage and prevented from moving during placement and curing of the concrete. Anchor bolt threads shall be protected from concrete contamination.

PART 4 - MEASUREMENT AND PAYMENT**4.1 MEASUREMENT**

A. The quantities of accepted work will be measured in the following units. All measurements will be plan measure except for authorized changes.

1. Description: Lump Sum

4.2 PAYMENT

A. Payment will be made at the respective unit or lump-sum price listed in the proposal and shall be full compensation for all labor, materials, and equipment necessary to complete the respective unit in place. There will be no separate measurement or payment for any item of work not specifically identified and listed in the proposal, and all such work shall be considered a subsidiary item with all costs pertaining thereto included in the prices for other items listed in the proposal. At the Engineer's option, partial payment may be made for any lump sum item listed in the proposal, providing that the Contractor is diligently and satisfactorily pursuing full completion of such partially complete item in accordance with the approved job progress schedule.

END OF SECTION

SECTION 34 23 72**OCS TUBULAR POLE INSTALLATION****PART 1 - GENERAL****1.1 SUMMARY**

- A. This Section covers the delivery to site and installation of new tapered tubular steel poles and accessory parts, for use as part of the Overhead Contact System (OCS) as shown on the Contract Drawings.

1.2 RELATED SECTIONS

- A. SECTION 01 33 00 – Submittal Procedures
- B. SECTION 01 43 00 – Systems Quality Assurance
- C. SECTION 34 23 10 – OCS Description and General Requirements
- D. SECTION 34 23 35.99 – OCS Pole Painting
- E. SECTION 34 23 37 – OCS Tubular Steel Poles
- F. SECTION 34 23 37.11 – OCS Pole Ornamentation
- G. SECTION 34 23 70 – OCS Installation
- H. Specifications for Street Lighting Attachments on OCS Poles shall be in accordance with Missouri Department of Transportation Governing Specifications and Special Provisions, in conjunction with Approval from the Engineer.
- I. Specifications for Traffic Signal Attachments on OCS Poles shall be in accordance with Missouri Department of Transportation Governing Specifications and Special Provisions, in conjunction with Approval from the Engineer.

1.3 REFERENCE STANDARDS

- A. The latest edition of the following reference specifications shall also govern the Work covered by this Section unless otherwise noted.

Sponsor	Number	Subject
MILSPEC	DOD-P-21035	Paint, High Zinc Dust Content Galvanizing Repair

1.4 SUBMITTAL

- A. Submittals shall be made in accordance with the requirements of SECTION 01 33 00 – Submittal Procedures, except as modified herein.
- The Contractor shall submit pole rake calculations for each pole.
 - The Contractor shall submit pole installation procedures.

1.5 QUALITY CONTROL/QUALITY ASSURANCE

- A. Quality control shall be in accordance with SECTION 01 43 00 – Systems Quality Assurance, except where varied herein.

1.6 HANDLING AND STAGING

- A. Any damage to the material and equipment shall be the Contractor's responsibility and all repairs shall be accomplished by the Contractor in accordance with the manufacturer's instructions, at the Contractor's expense.
- B. Pole staging areas shall be coordinated and approved with the Engineer prior to installation.
- C. Material shall not be stored in contact with the ground. It shall be stored in a manner and location that will not cause deterioration of the material.

PART 2 - PRODUCTS

Not Used

PART 3 - EXECUTION**3.1 PREPARATION**

- A. Initially verify the suitability of installation of the pole on the foundation by applying a template to the pole base.
- B. Perform any preparatory work necessary to install the pole such as chipping off concrete on anchor bolts and cleaning threads.
- C. Straightening of bent anchor bolts or replacement of damaged ones shall be performed in accordance with a procedure approved by the Engineer, at the Contractor's expense.
- D. A pole location survey and walkthrough shall be performed prior to installation of pole foundations. The overhead contact system contractor who installs the poles shall be included in this survey and walkthrough to verify proper pole locations and field conditions.

3.2 ERECTION/INSTALLATION

- A. Poles shall not be installed on foundations until 14 days after concrete pour and concrete strength as measured by test cylinders has achieved at least 90% of the minimum compressive strength specified.
- B. Poles shall be installed on the foundations where shown on the Contract Drawings as approved by the Engineer. The Contractor shall remove the protection cap, PVC protection sleeves, and cap from anchor bolts, prior to setting the pole.
 - 1. Rake poles to provide a vertical pole, with tolerance not to exceed 1 inch, when loaded.
- C. Grounding and Bonding: All steel poles installed by the contractor shall be bonded to the foundation grounding rod, using the grounding studs or lugs, and attached to the pole as shown on the OCS Contract Drawings. For tubular poles, grounding and bonding equipment may need to be installed prior to pole erection.
- D. Poles shall be set with handhole oriented in the direction facing away from track and with the Pole Type Identification Number facing tracks or curbs. Poles between two tracks shall be set with the handhole oriented in the direction of increased stationing.

- E. Pole fittings: The contractor shall install all bolted and clamped fittings required for specific installation including, but not limited to, the following items:
 - 1. Feeder Spouts.
 - 2. Accessories required for Ornamental Poles
 - 3. Accessories required for Lighting Pole attachments
 - 4. Accessories required for Traffic Pole Accessories
 - 5. Pole Caps
- F. Feeder poles:
 - 1. Feeder poles shall be fitted with a cable support ("J") Hook and terminating bushings at the cable entrance hubs. The terminating bushings shall be weatherproof, of compression seal type. The pull wire at the top of the pole shall be terminated with 2 (two) feet of free end length.
 - 2. Feeder poles shall be installed with the spouts perpendicular to track, and on opposite face of pole relative to track.
- G. OCS poles with Street Lighting Attachments:
 - 1. Refer to lighting drawings and specifications for street lighting attachment requirements.
- H. OCS poles with Traffic Attachments:
 - 1. Refer to traffic signal drawings and specifications for traffic attachment requirements.
- I. After complete installation of the pole the following information shall be recorded by the Contractor and submitted to the Engineer in the structure record drawings:
 - 1. Pole stationing and referenced track
 - 2. Pole size
 - 3. Pole length
 - 4. Face of pole to track centerline dimension
 - 5. Pole Rake
 - 6. Details and dimensions of any Accessories installed on the pole
- J. Signs and Markers shall be installed as specified in accordance with SECTION 34 23 70 – OCS Installation.

3.3 REPAIR COATINGS

- A. Field repair of zinc coated surfaces or painted surfaces shall be in accordance with SECTION 34 23 35.99 OCS Pole Painting.

PART 4 - MEASUREMENT AND PAYMENT**4.1 MEASUREMENT**

A. The quantities of accepted work will be measured in the following units. All measurements will be plan measure except for authorized changes.

1. Description: Lump Sum

4.2 PAYMENT

A. Payment will be made at the respective unit or lump-sum price listed in the proposal and shall be full compensation for all labor, materials, and equipment necessary to complete the respective unit in place. There will be no separate measurement or payment for any item of work not specifically identified and listed in the proposal, and all such work shall be considered a subsidiary item with all costs pertaining thereto included in the prices for other items listed in the proposal. At the Engineer's option, partial payment may be made for any lump sum item listed in the proposal, providing that the Contractor is diligently and satisfactorily pursuing full completion of such partially complete item in accordance with the approved job progress schedule.

END OF SECTION

SECTION 34 23 77**OCS SURGE ARRESTER INSTALLATION****PART 1 - GENERAL****1.1 SUMMARY**

- A. This Section covers the installation of surge arresters for the Overhead Contact System (OCS), as shown on the Contract Drawings, and specified herein.
- B. The Contractor shall provide and install surge arrester assemblies as shown in the Contract Drawings, including:
 - 1. All OCS poles serving as positive feeder cable risers
 - 2. Selected OCS poles as shown in the Contract Drawings
 - 3. On all poles with bypass disconnect switches, on both sides of the switch
- C. The Contractor shall design, supply and install the necessary attachments for supporting the surge arrester at the top of the pole as shown in the Contract Drawings. The Contractor's designs and technical data for these assemblies shall be formally submitted and subject to Approval by the Engineer.

1.2 RELATED SECTIONS

- A. The Contractor shall familiarize himself with the contents of the following Divisions/Sections of these Specifications:
 - 1. DIVISION 01 – General Requirements
 - 2. SECTION 01 33 00 – Submittal Procedures
 - 3. SECTION 01 43 00 – Systems Quality Assurance
 - 4. SECTION 26 05 26.13 Systemwide Electrical Grounding for Systems
 - 5. SECTION 34 21 50 – DC Surge Arresters
 - 6. SECTION 34 23 40 – OCS Wire and Cable
 - 7. SECTION 34 23 50 – OCS Assemblies, Components, and Fittings
 - 8. SECTION 34 23 70 – OCS Installation
 - 9. SECTION 34 23 80 – OCS Testing

1.3 REFERENCED STANDARDS

- A. ASTM B3 Standard Specification for Soft or Annealed Copper Wire
- B. ASTM B172 Standard Specification for Rope-Lay-Stranded Copper Conductors Having Bunch-Stranded Members, for Electrical Conductors

1.4 SUBMITTALS

- A. Submittals shall be made in accordance with the requirements of SECTION 01 33 00 – Submittal Procedures, except as modified herein.
- B. The following submittals shall be made:
 - 1. Test Procedures and Reports in accordance with SECTION 34 23 80 – OCS Testing.

PART 2 - PRODUCTS**2.1 SURGE ARRESTER**

- A. Surge arrester assemblies shall be in accordance with SECTION 34 21 50 – DC Surge Arresters, in conjunction with these Specifications.
- B. Each surge arrester shall be supplied with all accessories required for OCS pole mounting.

2.2 GROUNDING CONDUCTOR

- A. Extra-flexible bare cable: Copper, 4/0 AWG, Class I stranding, ASTM B3, ASTM B172.
- B. Insulated cable: Copper, 4/0 AWG, 2 kV rated insulation.
- C. Splice: C-type compression connector, Burndy Hyground or approved equal.
- D. Exothermic weld

2.3 GROUNDING CONNECTIONS

- A. Refer to SECTION 26 05 26.13 Systemwide Electrical Grounding for Systems for general requirements on grounding and bonding connections.

PART 3 - EXECUTION**3.1 INSTALLATION REQUIREMENTS**

- A. Surge arresters shall be installed at locations shown on the Contract Drawings in accordance with the arrester manufacturer recommendations and as specified herein.
- B. Mount in a position such that catastrophic failure shall not permit a positive cable to contact a pole.
- C. Energized side of surge arrester: Provide insulated cable from surge arrester to contact wire or switch, as indicated on Contract Drawings.

3.2 GROUNDING REQUIREMENTS

- A. Pole shall be field drilled with a hole to accommodate the surge arrester ground cable and protective grommets. Field drilled hole shall be coated with touch-up paint in accordance with the Specifications and the pole manufacturer.
- B. Where grounding cables are attached to surge arresters, sufficient slack shall be installed.
- C. Bonding cable connections between the surge arresters and the OCS, and between the surge arresters and the grounding system shall be installed with a minimum number of bends and connections. Bends in the cables shall be no less than 8 inch radius.

- D. Bonding connections between the surge arresters and the grounding systems shall be of the exothermic weld type.
- E. Each grounding connection shall achieve a grounding resistance of 5 Ohms or less, or as specified by the surge arrester manufacturer for the type of unit supplied, if the recommended resistance is less than 5 Ohms.

3.3 FIELD QUALITY CONTROL

- A. Each individual surge arrester grounding connection and system shall be tested in accordance with the testing procedures specified in SECTION 34 23 80 – OCS Testing.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

- A. The quantities of accepted work will be measured in the following units. All measurements will be plan measure except for authorized changes.
 - 1. Description: Lump Sum

4.2 PAYMENT

- A. Payment will be made at the respective unit or lump-sum price listed in the proposal and shall be full compensation for all labor, materials, and equipment necessary to complete the respective unit in place. There will be no separate measurement or payment for any item of work not specifically identified and listed in the proposal, and all such work shall be considered a subsidiary item with all costs pertaining thereto included in the prices for other items listed in the proposal. At the Engineer's option, partial payment may be made for any lump sum item listed in the proposal, providing that the Contractor is diligently and satisfactorily pursuing full completion of such partially complete item in accordance with the approved job progress schedule.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 34 23 78**OCS DISCONNECT SWITCH INSTALLATION****PART 1 - GENERAL****1.1 SUMMARY**

- A. This Section covers installation of pole mounted DC disconnect switches on OCS poles and connection to the OCS conductors, as shown on the Contract Drawings and specified herein.
- B. The disconnect switch assembly is to be used as an in-line switch in the OCS. It provides a means to disconnect OCS line sections from one another to enable de-energization of one of them. Disconnect switch assemblies will not normally be operated under load conditions.

1.2 RELATED SECTIONS

- A. The Contractor/manufacturer shall familiarize himself with the contents of the following Divisions and Sections of the Contract Specifications:
 - 1. DIVISION 01 – General Requirements
 - 2. SECTION 01 33 00 – Submittal Procedures
 - 3. SECTION 34 21 40 – TES DC Disconnect Switches

1.3 DISCONNECT SWITCH ASSEMBLY TYPES

- A. Disconnect switches are procured under SECTION 34 21 40 – TES DC Disconnect Switches. Each disconnect switch shall be operated using a manual operating handle mounted within reach of personnel on the ground.

1.4 REFERENCE DRAWINGS

- A. The locations of poles on which to mount disconnect switch assemblies are shown on the Contract Drawings.

1.5 SUBMITTALS

- A. Submittals shall be made in accordance with the requirements of SECTION 01 33 00 – Submittal Procedures, except as modified herein.
- B. For each type of disconnect switch, the following submittals shall receive approval by the Engineer before installation in the OCS:
 - 1. Complete manufacturer's descriptions, shop drawings, catalog data, enclosure color, electrical performance ratings and information including model number.
 - 2. Manufacturer's general and detail arrangement and dimensional drawings (shop drawings)
 - 3. The shop drawing for each assembly shall be referenced with the assembly reference and shall represent in full the equivalent project assembly drawing.
 - 4. Each shop drawing shall provide a complete list of its component materials for that specific type of assembly, including the identification of materials to be supplied by others, such as pipes, brackets, bolts, cables, jumpers and cable connectors.

5. Manufacturer's recommended installation instructions, including checks/tests after installation
6. Operation and maintenance manual with list of recommended spare parts

PART 2 - PRODUCTS

2.1 GENERAL

- A. Each switch enclosure shall be mounted near the top of a taper tubular OCS pole or feeder pole equipped with feeder spouts, and provided with up to two surge arresters. The height and orientation of the disconnect switch enclosure shall be agreed by the Engineer.
- B. All exposed unit outdoor switches shall be capable of operation with a 1/4-inch thick covering of glazed ice on the external switch mechanism.
- C. Switch Enclosures
 1. Non-metallic fiberglass switch enclosures shall be of a ventilated, rain-tight, tamperproof design suitable for outdoor application. The enclosure shall have a gasketed, heavy duty hinged door with padlockable handle, catch, full length hinge (one sided) and hooded ventilation openings with screens.
 2. One specified outdoor type padlock shall be provided with each cabinet (enclosure), all keyed alike. A dead front operating handle and linkage shall be provided inside the box for each switch.
 3. The switch position shall be visually indicated by the handle alignment with "OPEN" and "CLOSED" plates.
 4. The enclosure shall be of sufficient size to accommodate the switch, internal linkages and operating gear, cabling and terminations without electrical shorting or damage due to chafing on the feeder cable insulation. All maintainable components shall be readily accessible through the door opening, and sufficient space shall be provided for the manipulation of required tools.
 5. The exterior face of the cabinet shall be equipped with a switch data/nameplate and a Danger - High Voltage warning label permanently attached to the cabinet.
 6. The enclosure shall be a minimum of 1/4-inch thick polyester, with a glass to resin ratio of 40 to 60 and shall be equipped with a drain hole in the base. Resin shall be fire retardant polyglass or equal as Approved by the Engineer. Enclosure color shall be subject to Approval of the Engineer.
- D. Padlocks
 1. Each pole mounted disconnect switch shall be provided with an outdoor type, heavy duty, keyed padlock keyed to the requirements of the Owner, having a minimum hasp diameter of 2-inches.
 2. All padlocks shall be keyed alike. Two keys shall be provided for each padlock.

PART 3 - EXECUTION**3.1 INSTALLATION**

- A. The Contractor shall submit shop drawings for the disconnect switch support bracket for Approval by the Engineer before any switch is installed.
- B. Disconnect switches shall be field installed at OCS pole locations as shown on the Contract Drawings.
- C. Disconnect switches shall be installed in accordance with the manufacturer's instructions.
- D. The Contractor shall check the adequacy of poles for supporting the disconnect switches and accessories.
- E. All wiring shall be provided as required. All necessary additional hardware such as bolts and support brackets, couplings, bushings, connectors, grounding conductors, and all basic electrical materials needed for the installation of disconnect switch assemblies shall be supplied and installed by the OCS Contractor.
- F. Prior to energization of the OCS, the Contractor shall verify correct operation of all disconnect switches installed under this Contract, and shall demonstrate to the satisfaction of the Engineer the intended operation. Final switch positions shall be verified prior to OCS energizing without exception.
- G. The installation shall conform to the National Electrical Code (NEC).

PART 4 - MEASUREMENT AND PAYMENT**4.1 MEASUREMENT**

- A. The quantities of accepted work will be measured in the following units. All measurements will be plan measure except for authorized changes.
 - 1. Description: Lump Sum

4.2 PAYMENT

- A. Payment will be made at the respective unit or lump-sum price listed in the proposal and shall be full compensation for all labor, materials, and equipment necessary to complete the respective unit in place. There will be no separate measurement or payment for any item of work not specifically identified and listed in the proposal, and all such work shall be considered a subsidiary item with all costs pertaining thereto included in the prices for other items listed in the proposal. At the Engineer's option, partial payment may be made for any lump sum item listed in the proposal, providing that the Contractor is diligently and satisfactorily pursuing full completion of such partially complete item in accordance with the approved job progress schedule.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 34 23 80**OCS TESTING****PART 1 - GENERAL****1.1 SUMMARY**

- A. The Traction Electrification System and all its components shall be tested to verify compliance with all specified design, performance, reliability, and maintainability requirements.
- B. All tests described in this Section shall be performed as indicated unless specifically waived in writing by the Engineer. All tests shall be performed on production components without modification or special preparation.
- C. The tests specified herein are considered to be an absolute minimum by the Engineer. The Contractor shall be responsible for assuring that each design and performance requirement of this Specification is assigned to a specific test effort. The Contractor shall submit a comprehensive test program plan as specified. The Contractor and its subcontractors may perform additional testing, as they deem necessary.
- D. Material and other test requirements may also appear in other Sections. The Contractor shall integrate all of these tests into the Master Test Plan.
- E. After the Overhead Contact System (OCS) has been installed, and is to be made ready for operation, field acceptance testing shall be performed to verify physical and electrical integrity of the system, and to verify quality of workmanship.
- F. Following completion of all field acceptance testing, vehicle tests shall be performed to demonstrate clearances and commutation.
- G. This Section covers field-testing procedures, supply of test equipment and testing of the Overhead Contact System (OCS), visual inspections prior to energization, streetcar slow speed, commutation and pantograph clearance tests.

1.2 RELATED SECTIONS

- A. DIVISION 01 – General Requirements
- B. SECTION 01 33 00 – Submittal Procedures
- C. SECTION 01 43 00 – Systems Quality Assurance
- D. SECTION 34 23 10 – OCS Description and General Requirements
- E. SECTION 34 23 37 – OCS Tubular Steel Poles
- F. SECTION 34 23 40 – OCS Wire and Cable
- G. SECTION 34 23 50 – OCS Assemblies, Components and Fittings
- H. SECTION 34 23 70 – OCS Installation
- I. SECTION 34 23 71 – OCS Pole Foundations
- J. SECTION 34 23 77 – OCS Surge Arrester Installation

K. SECTION 34 23 78 – OCS Disconnect Switch Installation

L. SECTION 34 23 90 – OCS Installation Records

1.3 REFERENCED STANDARDS

A. See Referenced Standards in SECTION 34 23 10 – OCS Description and General Requirements.

1.4 SUBMITTALS

A. Submittals will be in accordance with SECTION 01 33 00 – Submittal Procedures. Submit a Test Program Plan for approval within 60 days of the Notice to Proceed. The Test Plan shall be used as a controlling document for all tests and shall include test procedures and proposed test reports. The purpose of this plan is:

1. Ensure that the Contractor has considered all of the testing requirements contained in this and other Sections of the Specifications, and has made adequate provisions for testing in his overall program plans and schedules.
2. Achieve an early mutual understanding between the Contractor and the Engineer on the range, depth and other aspects of tests to be conducted.

B. The Test Program Plan shall contain as a minimum the following data:

1. Title of each test with reference to the respective article or Section number in the Specification
2. The name of the agency performing each test, a description as them being Contractor, his supplier, or an independent testing company
3. Test locations
4. Submittal date for each test procedure, test report, and/or certified test document
5. Scheduled starting date for each test
6. Scheduled completion date for each test
7. Test objectives
8. Test criteria
9. A list of test equipment to be available on site during OCS installation, including optical stagger gauge or laser equipment, insulated height stick, mechanical pantograph gauge suitable for use on embedded track, insulated tape measures, a 6ft hand level, and a pantograph profile with sway “ears”
10. Personnel requirements
11. Test input and expected output
12. Data to be recorded and form of data
13. Test evaluation procedures
14. Nature of required reports
15. A sample of each type of form proposed for use

16. A list of individual contact wire heights and staggers for every contact wire support or registration points for each step of the OCS configuration, on a stage-by-stage, step by step work schedule
 17. A list of acceptance measurements to be recorded upon completion of the OCS construction
- C. Prior to each test, the Contractor shall submit verification that the OCS meets the specifications to the Engineer.

1.5 QUALITY ASSURANCE/QUALITY CONTROL

- A. Quality Control/Quality Assurance shall be in accordance with SECTION 01 43 00 – Systems Quality Assurance except where modified within this Specification Section.

1.6 SAFETY REQUIREMENTS

- A. The health and safety of workers and the public shall be in accordance with all Federal, State, and Local regulations, as well as any requirements stipulated by the Owner or Engineer.

1.7 TEST PROCEDURES

- A. The Contractor shall develop detailed test procedures, which include test report format and forms for recording data for each test. The Contractor shall submit five copies, or at the Engineer's preference, a PDF file, of each test procedure. The test procedures shall include applicable procedures specified in, but not limited to, ANSI, IEEE, or NEMA standards. A set of test procedures shall be prepared for each assembly and component in this specification.
- B. Test procedures must be reviewed and approved by the Engineer prior to commencement of each test. Each test procedure shall contain a step-by-step procedure for performing the test and shall include but not be limited to the following:
1. Title of test
 2. Test objective
 3. Test location and time
 4. Required equipment and instrumentation
 5. Test criteria including data evaluation procedures
 6. Test methodology including test setup, with circuit diagrams and test sequence
 7. Test data requirements including forms and format for recording data
 8. Testing agency or company

1.8 TEST REPORTS

- A. The results of each test shall be recorded on approved test report forms. Each report shall document the test results obtained and shall include the following information:
1. Title of test
 2. Test objectives
 3. Summary and conclusions

4. Location and date of test
5. List of all test equipment used with calibration data
6. Conditions of test, including temperature and humidity
7. Raw test data
8. Reduced test data including tables, curves, photographs and any additional test data required to support the test results
9. Test results in a form which can easily be compared to the Specification requirements
10. Descriptions of all equipment and material failures, the reasons for the failure
11. Descriptions of all modifications to the equipment or wiring performed using the testing, and the reasons for the modifications, and the names of individuals approving such modifications
12. Abbreviations and references
13. Signatures of test witnesses

1.9 WITNESSING OF TESTS

- A. The Engineer will, at his option, witness all tests. At least 21 days prior to each test, the Contractor shall notify the Engineer in writing of the date, time, and location the test will be performed. If the Engineer decides not to witness a test or tests, test reports shall nevertheless be submitted to the Engineer for approval.
- B. The Witnessing of tests shall not be considered as acceptance of test results or test reports.

1.10 PERFORMANCE OF TESTING

- A. Factory design or production testing of individual components may be performed by the component manufacturer at the plant of manufacture or at an approved testing facility.
- B. Field testing shall be performed by the OCS installer under the direct supervision of the field service engineer representing the manufacturer of the OCS equipment and the Contractor.
- C. Field testing of insulated power cables rated 2 kV and higher shall be performed by a NETA certified technician working for an independent testing company under the direct supervision of the manufacturer of the substation equipment, and hired by the manufacturer of the substation equipment. The NETA technician shall have at least five years experience in construction acceptance testing. The testing company shall be a NETA member and shall be approved by the Engineer. After approval by the Engineer, the testing company shall not be discharged or otherwise replaced without his written approval.
- D. Streetcar testing of the complete OCS installation shall be performed by the OCS installer under direction of the field service engineer representing the manufacturer of the OCS equipment and the Contractor.

1.11 TEST CLASSIFICATIONS

- A. The required tests are categorized as follows:
1. Factory design tests shall be conducted by or under the supervision of the equipment manufacturer to demonstrate compliance with specified design requirements. These tests shall be performed on production components, assemblies, subsystems, and substations, and shall be performed on the highest level of assembly that will allow demonstration of design compliance. Design tests are limited to the number of units needed to demonstrate design compliance, typically one or two.
 2. Factory production tests shall be conducted by or under the supervision of the equipment manufacturer and include all efforts necessary to demonstrate that the unit to be delivered operates within specified limits and is in compliance with design requirements. Production test requirements may vary from an inspection and functional demonstration for a simple component to a full system functional demonstration of an assembly. Production tests shall be performed at the OCS manufacturer's facility prior to shipment of the OCS equipment to the field. These tests are routinely performed at the ambient conditions unless a specific environmental or operating limit is necessary to demonstrate acceptable operation.
 3. Field acceptance tests shall demonstrate that each installed OCS segment is ready for vehicle testing functionally and revenue service cosmetically. Field tests include Measurement, Mechanical, Clearance, Electrical, and Energization tests.
 4. Vehicle tests shall demonstrate clearances to pantograph and vehicle body, and operation at maximum permissible speed without loss of contact or physical interference with a pantograph by the OCS.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. The Contractor shall supply all tools and equipment for performance of the tests.

PART 3 - EXECUTION

3.1 FACTORY DESIGN TESTS

Component design tests shall be run on each component specified in this Section, and submitted to The Engineer for approval. If the manufacturer of the equipment has already performed design tests, the existing test reports may be submitted to the Engineer for approval. Existing test reports will not be required to meet the format requirements specified in this Section; however the content of the reports shall include all relevant information. In the event the components have not been design tested, the tests shall be run on the first production units and performed in accordance with these Specifications.

- A. OCS Insulators

The following design tests shall be performed as described in ANSI C29.1 for one insulator of each type and rating supplied:

1. Power Frequency Withstand
2. Impulse Withstand
3. Thermal Capacity

4. Mechanical Strength

5. Resistance

B. OCS Section Insulators

The following design tests shall be performed for one section insulator of each type supplied:

1. Resistance to ultraviolet radiation and electrical tracking of the insulating material

2. Mechanical Strength

3. Electrical Tests per section 3.1.A

C. OCS Disconnect Switches

The following design tests shall be performed as described in ANSI C37.34 for one OCS disconnect switch of each type and rating supplied:

1. Insulation resistance and high potential tests

2. Temperature rise

3. Short time current

4. Interrupting current

D. Poles

1. The contractor shall demonstrate the deflection of each type of pole procured under this Contract to the engineer. The demonstration shall be in the form of a factory design test, performed in the place of the manufacturer. The testing shall be non-destructive and at a time and place agreed by the Engineer. The parameter to be demonstrated is the deflection at the top of the pole. The purpose of the test is to determine that the type of pole has deflection characteristics that match or are lower than predicted by theoretical considerations.

a. For each Pole Type to be tested, the maximum allowable moment that can be applied to the base of the pole shall be calculated based on the properties of the material specified and the dimensions shown on the drawings for that Pole Type. Calculation of the maximum allowable moment shall take into account the effects of local buckling, if appropriate. The magnitude of the load applied to the top of the pole to apply the maximum allowable moment to the base of the pole shall be calculated and the pole tested by application of this load in 1/3 increments. The deflection of the top of the pole shall be measured and recorded for each load increment. At release of the full test load, measure and record any permanent set (deflection past the neutral point) of the pole.

b. In the case of tapered tubular poles, the theoretical deflection for application of these load increments may be calculated in accordance with Deflection Equations for Tapered Tubular Cantilevered Beams of the "Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals" by the American Association of State Highway and Transportation Officials or other approved methods.

- c. The theoretical calculated deflections shall be compared with the values measured and the pole shall be determined to have passed the deflection test if none of the measured values are greater than the theoretical value plus 10%. Measured values less than the theoretical calculated values shall be considered as complying with these requirements. Permanent set of the pole shall not be greater than 5% of the deflection that occurred under the maximum load.
2. The Contractor shall submit to the Engineer, in writing a test procedure for approval, prior to testing of any poles. The test procedure shall include method of application of loads, recording devices, calibration of devices, method calculation of theoretical deflections and any information deemed pertinent by the Engineer. The test procedure shall comply with the following minimum requirements:
 - a. Test Arrangement - Poles will normally be placed in a horizontal position for testing although the vertical position is allowed. The pole shall be bolted to a rigid foundation that resists all translation and rotation about any axis. Provision shall be made to accurately measure the load applied to the pole, deflection at the top of the pole and to monitor the movement of the test foundation at the base of the pole to confirm its rigidity.
 - b. Test Equipment – The loads shall be applied at the top of the pole by a crane or other suitable pulling devices. Loads shall be measured by using calibrated scales or load cells located in the pulling lines. Loading and/or measurement through a system of blocks, tackles or pulleys shall not be allowed.
 - c. Dead Load Pick Up – The load required to compensate for the dead weight of the pole in its horizontal position shall be calculated and added to the test load increments.
 - d. Loading Procedure – The pole shall be loaded with the required Dead Load Pick Up load and reference established to measure deflection of the top of the pole from this point. The pole shall be loaded by 33, 66, and 100 percent of the load calculated to apply the maximum allowable moment at the base of the pole. Each load shall be applied in a steady uniform manner from the Dead Load Pick Up load to the value of the increment plus the Dead Load Pick Up value and held for 3 minutes. The deflection of the top of the pole shall be measured at the start and end of the hold period to confirm no creep is occurring. If creep is detected, continue hold until deflection readings stabilize. If creep is detected after 10 minutes of hold, the pole is considered to have failed the test. Confirm that the no movement has been detected in the test foundation at the base of the pole. If movement is detected, take necessary steps to eliminate the movement and retest the pole. After the deflection has been measured, decrease the load in a gradual uniform manner to zero.
 - e. Reapply the Dead Load Pick Up load and compare with previous reference point(s) and establish new reference point if required. Record permanent set, if any. Apply load to next increment value and repeat above procedure for each increment (plus Dead Load Pick Up) value.
 - f. Recorded values for deflections measured at each increment and permanent pole set, if any, shall be compared with the above requirements and the pole type shall be accepted as passed if the results are within the requirements listed.

3. If the requirements are not met, that particular individual pole shall be rejected for use on the project and another pole of the same Type tested. If the second pole of the same Type does not meet these requirements, that pole will be rejected for use on the project and two additional poles of that Type shall be tested as above. If both poles meet the above requirements, the Pole Type will be accepted for use on the Project. If either pole does not meet the requirements, all poles of the Type tested shall be tested by the above method for acceptance for use on the Project.
4. The cost of this testing, any required re-testing, and the issue of test reports shall be included in the bid price, and no additional compensation will be paid to the Contractor.

3.2 FACTORY PRODUCTION TESTS

Component Factory Production tests shall be run on each component specified in this Section, and submitted to the Engineer for approval.

A. Fittings, Hardware, and Cantilever Tubes

1. The following production tests shall be performed in accordance with ASTM standards:
 - a. Chemical Analysis Tests on each lot.
 - b. Sample galvanizing tests upon completion of fabrication.
 - c. Visual and dimensional tests upon completion of fabrication.
 - d. Tests to determine thread fittings of units, washers, and bolts.
2. A lot shall consist of all castings produced by one furnace melt.

B. Disconnect Switches

The following production tests shall be performed as described in ANSI C37.34 for each disconnect switch of each type and rating supplied:

1. Insulation resistance and hi-potential test.
2. Mechanical operation of all components.

C. Galvanized Steel Wires and Wire Rope

All grades of stranded steel wires used as support wires, guys, and pull offs shall be tested in accordance with ASTM A475.

D. Stainless Steel Wire and Wire Rope

1. Stainless steel wire and wire rope used as support wires and pull-offs shall be tested in accordance with ASTM A555, ASTM A368 and ASTM A492.
2. Test reports shall be submitted.

E. Section Insulators

1. The following tests shall be performed in accordance with the applicable ANSI/IEEE Standards:
 - a. Dry flashover tests
 - b. Wet flashover tests

- c. Low frequency dry withstand test
 - d. Low frequency wet withstand test
 - e. Impulse withstand test
2. The Contractor shall provide data to show that the insulator material is resistant to ultra-violet radiation and electrical tracking.
 3. The messenger insulators shall be proof tested in accordance with the applicable Section of the Specifications, and the contact wire insulator shall be tension-proof tested to applicable contact wire maximum tension plus design factors of safety.
 4. All test reports shall be provided.

F. Insulators

The following production tests shall be performed in accordance with ANSI C29.1.

1. Visual and Dimension Tests:
 - a. The entire surface shall be smooth and free from defects.
 - b. If adhesives are used, the insulator shall be inspected to see that the fillet of adhesive provides a complete seal between the coating and end fitting.
 - c. The insulator shall be inspected to verify that both end fittings are in line after being assembled on the rod.
 - d. The insulator shall be in accordance with the approved shop drawings and specifications.
2. Routine Flashover

A sampling of not less than 5% of each type of insulator shall be subject to a flashover test in accordance with ANSI C29.1.
3. Proof Test

All insulators shall be subject to a mechanical strength proof test. The insulators shall be tested at room temperature for 10 seconds to 120% of the designed tensile, compressive or bending load, failure shall constitute rejection.

G. Overhead Contact System Conductors

1. All conductors shall be subject to factory quality control tests as required in the applicable Standards. Tests shall be required on each reel of wire prior to shipment to site. A certified copy of the test report for each reel shall be submitted to the Engineer. A copy of the test report shall be packed with each reel.
2. The OCS contact wire shall be tested in accordance with ASTM Standard B47. In addition, the contact wire shall be subject to a twist test. The twist test shall be performed as specified for round wire, except that six twists shall be required. Contact wire not meeting the twist test shall be rejected.

H. Poles

1. Material Testing shall be in accordance with Reference Standards given in SECTION 34 23 37 – OCS Tubular Steel Poles.

2. Weld Testing shall be in accordance with AWS Specifications, as per SECTION 34 23 37 – OCS Tubular Steel Poles.
 3. Impact Testing shall be in accordance Reference Standards given in SECTION 34 23 37 – OCS Tubular Steel Poles.
 4. Galvanizing Testing shall be in accordance Reference Standards given in SECTION 34 23 37 – OCS Tubular Steel Poles.
- I. All galvanized items shall be inspected for conformance with the requirements of the following ASTM specifications, as applicable:
- a. Galvanizing Compliance: A123 or A153
 - b. Embrittlement: A143
 - c. Distortion: A384

J. Inspection

Provisions shall be made for inspection of the fabrication and testing by the Engineer or his authorized representative. Inspection by the Engineer at the point of manufacture shall not constitute acceptance of the Work as specified.

3.3 VERIFICATION PRIOR TO FIELD TESTS

Prior to conducting the field tests, the Contractor shall verify that the OCS equipment is installed according to the Contract Drawings and specifications, and is in operable condition.

- A. Verify the physical integrity and quality of workmanship of the system installation.
- B. Verify electrical clearances equal or exceed criteria.
- C. Verify clearance envelope for vehicles and pantograph are not infringed.
- D. Verify electrical integrity of the system.

3.4 MEASUREMENT TESTS

- A. Upon completion and acceptance by the Engineer of each segment of construction, the Contractor shall measure the contact wire height, stagger, and other required dimensions and record the readings on a Measurement Test Data Form, in the presence of the Engineer's representative.
- B. Tests shall be scheduled in advance with the Engineer.
- C. The Acceptance Measurement Data form provided shall be used to record test data. A typical blank Acceptance Measurement Data form for catenary equipment is shown in Table 3.1.
- D. Since the OCS is a single contact wire fixed terminated system, all references to the messenger wire, balance weights, along track movement and other non-occurring issues, shall be struck through.
- E. All columns on the test form will be completed using data from field measurements taken in the presence of the Engineer's representative, from existing records or from computed data as noted. Descriptions of the OCS Measurement Test Data form fields and the procedures used for the associated testing follow:
 1. Track – Designation shown on the Contract Drawing

2. Wire Run Number – Designation shown on the Contract Drawings
3. Drawing No. – Of the OCS Layout Schedule where structures are to be shown and labeled
4. Names – Of the persons responsible for the measurement and their respective organizations
5. Sheet No. – Number in the series of forms on which the wire run measurements are to be shown
6. Equipment Style – The style of catenary being measured
7. Conductor Temperature – Temperature (°F) of the conductors at the time of measurement. This measurement will be monitored by the use of a dial-type thermometer inserted into a hole bored lengthwise into a 10” length of contact wire. The thermometer contact wire assembly will be held under the same ambient conditions as those experienced by the installed OCS.
8. Weather and Air Temperature – Conditions at the time of measurement; temperature will be measured on-site
9. Date – Of the measurement
10. Station No. Identification – Support structure stationing as shown on the layout schedules
11. Structure Set out (Pole Face to centerline of track distance) – Measured distance from the pole to abutment face to track centerline, taken with tape measure
12. Foundation Height – Measured height from top of foundation to top of near rail, + above rail, - below rail
13. Crosslevel (Superelevation) – Difference between the elevators of the two rails measured at the structure location
14. Stagger – Distance from the contact wire to the super-elevated centerline of the track measured at the support location. This measurement will be taken using a catenary position measurement device. Stagger shall be recorded as L (left) or R (right) when viewed in the direction of increasing stationing. Record stagger to nearest ½ inch.
15. CW Height – Distance from the contact wire to a line defined by the top of both rails at the point of measurement (the inclined reference point)
16. System Height – height of messenger wire above the contact wire measured at the support. This value is computed from measurements of messenger wire and contact wire heights taken from track level. (Struck through for single contact wire.)
17. Midspan Offset – Same as “Stagger” above, except taken at midspan. Same sign convention applies
18. Midspan C.W. Height – Same as “CW. Height” above, except measured at midspan
19. Midspan Crosslevel – Same as “Crosslevel” above, except measured at midspan. Measurement will be taken using level and tape measure.
20. Sag – The computed average of “C.W. Height” for the previous and next structure minus Midspan C.W. Height between the structures

21. Gradient – Rate of change of contact wire height; computed as the difference between contact wire height at two adjacent supports divided by the distance between the supports
 22. Span Length – Along track distance between the two OCS supports
 23. Balance Weight Rise or Fall – Position of balance weight at ambient temperature relative to the computed 60°F position. (Struck through for Fixed Terminated Systems.)
 24. Position of Balance Weight Stops – Position of upper and lower balance weight top relative to foundation upper surface, taken from design calculations. (Struck through for Fixed Terminated Systems.)
 25. Mean Balance Weight Position at 60°F – Position of balance weight top relative to foundation upper surface; taken from design calculations. (Struck through for Fixed Terminated Systems.)
 26. In-Running Contact Wire Height – height of in-running contact wire at overlaps and turnouts
 27. Out-of-Running Contact Wire Height – height of out-of –running contact wire at overlaps and turnouts
 28. Bridge Clearance Approximate Station – Approximate station location of bridge clearance measurement, as measured from the nearest catenary pole location
 29. Bridge Face/Low/Mid- Designate whether the measurement is taken at a bridge face, the bridge midpoint, or at the estimated low point of the bridge lower surface
 30. Bridge Vertical Track Clearance – Vertical distance between the underside of the bridge and the superelevated centerline of the track
 31. Messenger Wire to Bridge Distance with 50 lbs. C.W. (Struck through for single contact wire.)
 32. Remarks – as necessary
- F. The Engineer will use the Acceptance Measurements to determine compliance with the designs and will inform the Contractor of necessary corrections to be performed.
- G. The Contractor shall execute corrections at no further cost to the Engineer, except for adjustments required by the Engineer which are changes beyond the requirements specified in the Contract Documents.
- H. After executions of corrections, the Contractor shall re-measure and record affected data and submit the results to the Engineer.
- I. The Work of this Section shall not be complete until corrections are complete and approved by the Engineer.
- J. Completed Acceptance Measurement Tables shall be submitted in accordance with SECTION 01 33 00 – Submittal Procedures.

3.5 MECHANICAL TESTS

- A. Upon completion of the OCS installation, the Contractor shall verify the physical integrity of the complete system.

- B. The Contractor shall check, by visual inspection from ground level, that all the OCS components are correctly installed:
1. Catenary poles are vertical.
 2. Steady arms are correctly positioned.
 3. Feeder disconnect switch operating mechanisms operate freely and correctly and switch-blade position corresponds to handle position.
- C. Following Measurement Tests, the Contractor accompanied by the Engineer's representative, shall carry out the following checks at contact wire level, and remedy any unsatisfactorily conditions detected:
1. Check fit and tightness of all components.
 2. Check that all split pins and locknuts are secure.
 3. Check that the contact wire is free of kinks, twists, nicks or damage.
 4. Check stranded wires are free of damage to strands.
 5. Check steady arm heel settings and fittings are correct.
 6. Check that jumpers are of the correct type, have adequate travel capability, are properly fitted, and are well formed to avoid fatigue failure.
 7. Check that the clearance of wires passing through a cantilever at the same potential is at least 3 inches under normal climatic conditions.
 8. Check for clearance and insulation between adjacent or crossing contact wires.
 9. Check installation for locations of possible interference with passage of pantographs, including spots where pantographs could tangle with wires or suspension assemblies.
 10. Check that orientation of bolts, nuts, and pins are consistent to the extent possible.
- D. From the ground, the Contractor shall make the following checks:
1. Check that all disconnect switch operating handles operate correctly and name plates are correctly positioned.
 2. Check that the disconnect switches operate easily and that the blades open and close smoothly without sticking.

3.6 CLEARANCE TESTING

- A. Overhead Contact System
1. The Contractor shall measure clearances between the conductors, OCS equipment that will be energized, and any fixed structure such as an overhead bridges. Corrections for temperature shall be made, for fixed terminated catenary, and for uplift of the conductors. Clearances shall be equal to or exceed the values given in these Specifications.
 2. The purpose of these tests is to verify the mechanical and electrical clearances of the vehicle pantograph on the system. Any section found to have insufficient clearance shall be adjusted to provide the required clearance.
- B. Pantograph Clearance Envelope

1. The Contractor shall perform pantograph clearance envelope inspections. The purpose of these inspections is to verify the mechanical and electrical clearances of the pantograph on the OCS. The inspections shall be conducted after all installations are complete. Any OCS assembly found to have insufficient clearance shall be adjusted to provide the required clearance.
 2. Inspections shall be performed with a rail mounted height and stagger gauge having the profile of the appropriate pantograph clearance envelope. This gauge shall be used to verify the mechanical clearances between the pantograph and OCS components such as the heels of steady arms and drop brackets, and the electrical clearance between the pantograph and civil structures, such as overbridges. For this purpose the contact wire shall be uplifted before clearance measurements are taken. All measurements shall be recorded.
- C. Vehicle Mechanical Clearances to OCS Supports (excluding Pantograph)
1. Vehicle Clearance Inspections shall be performed using a rail mounted sway gauge based upon the streetcar clearance diagram appropriate to the section of track being checked, and allowing for track curvature, superelevation and track tolerances. Equipment shall be clear of the sway gauge by a minimum of 3 inches.
 2. Alternatively, the clearance from face of the OCS structure to track centerline shall be measured at each structure and compared to the vehicle dynamic envelope dimension for the track curvature and superelevation. All parts of the OCS structure including pole, switch operating mechanism, cables and cable cleats, etc. which are lower than the streetcar roof line shall be clear of vehicle envelope by a minimum of 6 in. to allow for pole rake, track tolerances and mechanical running clearance.

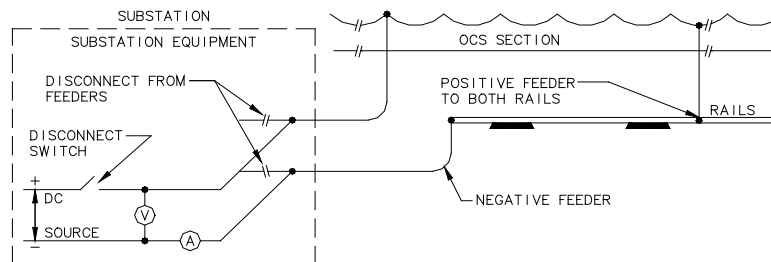
3.7 TESTS WITH A STREETCAR

- A. Upon completion of the Measurement, Mechanical and Clearance Tests, the Contractor will initiate a low speed de-energized streetcar test run to confirm acceptable pantograph performance. A visual inspection of the pantograph interface to the wire will be performed. The test will demonstrate that the pantograph passing electrical clearances are adequate, no physical interference with pantograph movement, and sufficient pantograph security. During these test, the Contractor shall have available plant, equipment and labor able to perform minor modifications to the OCS equipment.
- B. The Contractor shall conduct a survey of the installed contact wire with a streetcar and equipment. The test equipment shall include a chart recorder or similar equipment for continuous recording of voltage, current and contact interruptions, and a video tape camera and recorder to record the pantograph head tracking on the OCS. Tests shall be performed to verify no contact losses between the vehicle pantograph head and the contact wire up to the maximum permissible speeds under normal operating conditions, and to demonstrate adequate pantograph passing electrical clearances, no physical interference with pantograph movement, and sufficient pantograph security.

3.8 ELECTRICAL TESTS

- A. Electrical Tests
1. Continuity Tests
 - a. With the OCS section de-energized the Contractor shall make a series of continuity tests to prove the continuity of each section of catenary and track in the area.
 - b. Each OCS section shall be formed by shorting the OCS to the track with jumpers at one end of the test section. Refer to Figure 3.1.

- c. The Contractor shall provide a 12 V battery, a current measuring shunt, voltmeter, ammeter, and a switch to allow voltage and current measurements to be made.
- d. The Contractor shall record the results of the test and shall average the results of three loop resistance measurements using Table 3.3. A passing test shall constitute a nominal loop resistance not exceeding 0.1 ohm per mile of single track simple catenary style construction or 0.3 ohm per mile of single wire style construction. The cause of higher loop resistance values shall be investigated and addressed to the satisfaction of the Engineer.



CONNECTION FOR THE DC LOOP RESISTANCE TEST
(CONTINUITY TEST)

Figure 3.1

B. Dielectric Test

1. With the OCS de-energized, and with all surge arresters disconnected, the Contractor shall connect a 1000 volt megger between the catenary and the rail at one end of each test section as shown in Figure 3.2. The resistance in each test shall be noted on Table 3.4. A resistance value of greater than 5 M ohms is required to be obtained before continuing with the tests described in the Hi-Pot Insulation Testing Section.

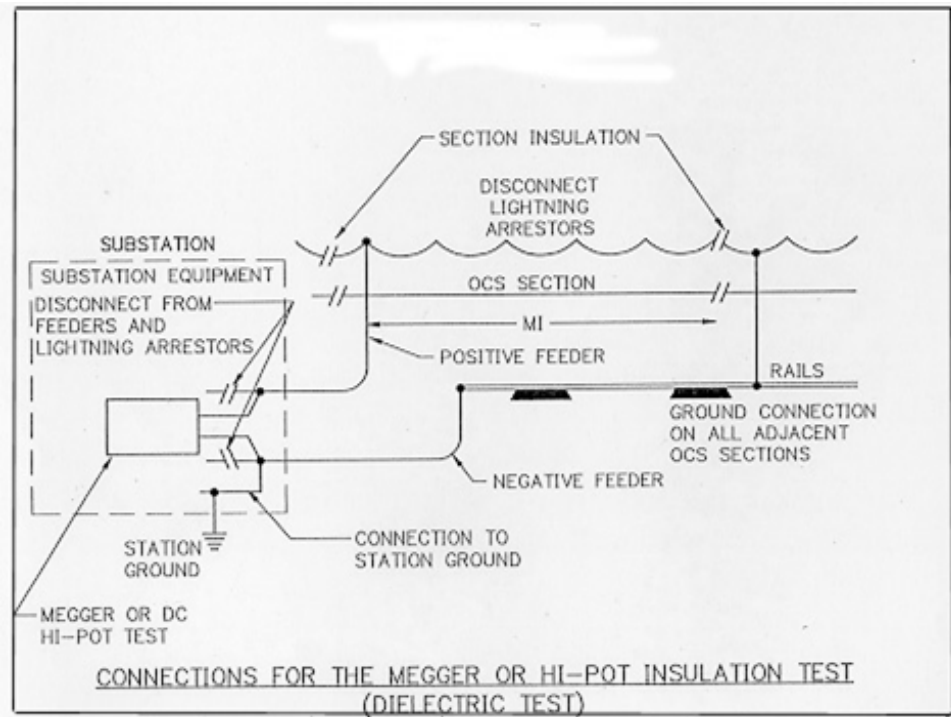


Figure 3.2

C. Hi-Pot Insulation Testing

1. General: The Contractor shall replace the 1000 volt megger with a DC hi-pot test set. DC Hi-pot test shall be performed on discrete sections 1 to 2 miles in length of the OCS. The Hi-pot tests serve the following purposes:
 - a. Components such as insulators and feeders are checked for leakage.
 - b. The electrical withstand of section insulators and disconnect switches are verified.
 - c. The test provides a means of periodically checking for any reduction in the insulation level of the OCS sections, by comparing voltage and leakage current with previously measured values.
 - d. A nominal Dc Hi-pot voltage of 2.5 kV shall be used for the test. Hi-pot tests shall be carried out on the OCS sections as soon as possible after the continuity tests have been completed, in order to ensure that all of the section being tested is electrically continuous and is subjected to the test voltage. Leakage currents between 0 and 5 mA can be expected for section lengths of 1-2 miles.

2. Precautions: The Hi-pot measurements require application of high voltage to the OCS. Proper regard must be paid to safety. Test zones shall be clearly identified. All safety requirements established in the Safety program concerning the public, work personnel and equipment shall be strictly enforced. Personnel not directly associated with the tests should be clear of the tracks. Sections of OCS and associated sections of the system, and all OCS sections adjacent to the section under test shall be grounded.
3. Procedure: Adjacent OCS sections which are electrically isolated from the section under test shall be grounded by connecting the OCS to the rails. The Contractor shall verify that a low resistance path exists for all the rails between all grounds and the test ground connections. All surge arrestors shall be disconnected from the section under test. A DC voltage shall be applied to the OCS section per figure 3.2 in 500 volt steps up to 2500 V. Before each measurement is read, the Contractor shall allow one minute to pass in order to stabilize the level of leakage current. Leakage current shall not exceed 5 mA per mile at 2500 V. The Contractor shall record the results in Table 3.4. The cause of leakage currents in excess of 5 mA per mile, or unstable current readings shall be investigated and addressed to the satisfaction of the Engineer. The test voltage shall be held for 30 seconds. The leakage current at each value shall be measured and recorded together with the weather conditions and temperature.

D. Ground Resistance Measurement for Surge Arresters

1. General: Prior to acceptance, the ground resistance of the ground connections for the surge arrestors shall be measured and recorded in accordance with the test procedure. Grounds for surge arrestors with a ground resistance measurement greater than 5 ohms shall be supplemented by adding ground rods until a grounding resistance of 5 ohms or less is achieved.
2. Procedure:
 - a. Connect the megger as shown in Figure 3.3. Note that the lead from P1C1 should be as short as possible and that the electrodes and the ground rod must be in a straight line. It is not essential for the electrodes to be parallel to the track, but this configuration will probably be the most convenient.
 - b. Position the electrodes at distances as shown in Table 3.2 test position 1, i.e. with $x = 66$ feet $y = 105$ feet. To ensure acceptance values of resistance, the ratio of distance (x/y) must be approximately 62 percent. Insert current and potential electrodes into the earth approximately 6 to 10 inches, for very dry soil pour water around the current electrode. Measure and record the resistance.
 - c. Keeping the x dimension the same as in step b, reposition the current electrode to $y + 6$ feet. Measure and record the resistance.
 - d. Compare the resistance values obtained in steps b and c. If the readings obtained are within 5 percent of each other, no further measurements are required and the average value should be used as the actual resistance. If the readings differ by more than 5 percent, increase x by ten feet and make y equal to $(x + 10) / 0.62$ approximately. Repeat steps b, c, and d as necessary.
 - e. Repeat this procedure for each surge arrester location.

- f. A measured ground resistance value of 5 ohm or less is considered acceptable.

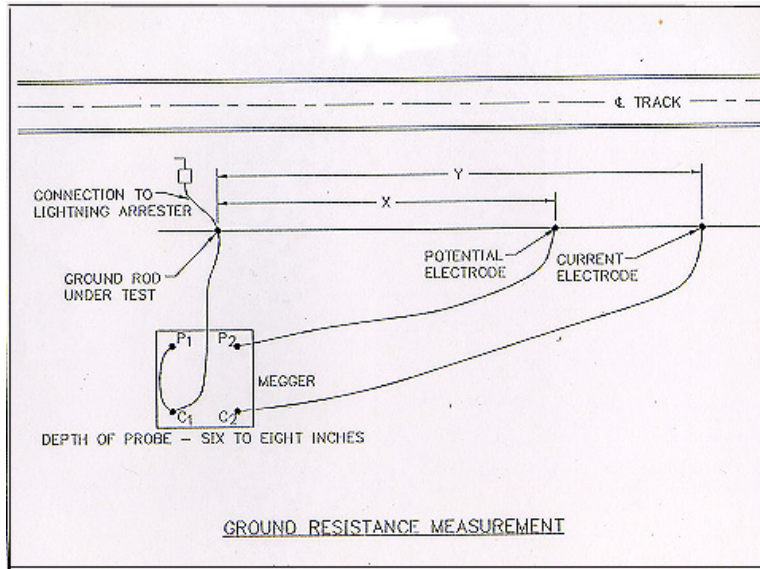


Figure 3.3

3.9 OCS ENERGIZATION TEST

- A. In conjunction with the Traction Power Substation testing each electrical section of the OCS shall be energized under the direction of the Engineer.

3.10 VEHICLE TESTS

- A. Arc and Spark
 - 1. Vehicle testing shall be performed on the OCS at low speeds and operating speeds to verify arc-free commutation.

3.11 SAMPLE TEST FORMS

TABLE 3.2
GROUND RESISTANCE

ARRESTER LOCATION	TEST POSITION	DISTANCE X (ft.)	DISTANCE Y (ft.)	MEASURED GROUND RESISTANCE	AVERAGE GROUND RESISTANCE FOR STR. LOCATION
	1	66	105		
	2	66	111		
	3	76	122		
	4	76	128		

Tested By: _____ Date of Test: _____
 Supervised By: _____
 CM Witness: _____

TABLE 3.3
DC LOOP RESISTANCE

DATE _____ TEMPERATURE _____
WEATHER CONDITIONS _____

NO.	SECTION DESIGNATION	LENGTH (MILES)	VOLTAGE (V)	CURRENT (A)	LOOP RESISTANCE	
					TOTAL	PER MILE

1000V MEGGER RESISTANCE = _____

Tested By: _____ Date of Test: _____

Supervised By: _____

Witness: _____

TABLE 3.4
HI-POT TEST

APPLIED VOLTAGE (V DC)	LEAKAGE CURRENT (micro Amps)
500 (HOLD 60 SEC.)	
1000 (HOLD 60 SEC.)	
1500 (HOLD 60 SEC.)	
2000 (HOLD 60 SEC.)	
2500 (HOLD 60 SEC.)	

LENGTH OF SECTION (MILES)=
LEAKAGE CURRENT PER MILE AT 2.5 KV =
NUMBER OF INSULATORS IN SECTION =
LEAKAGE CURRENT PER INSULATOR =

Tested by: _____ Date of Test: _____

Supervised By: _____

CM Witness: _____

PART 4 - MEASUREMENT AND PAYMENT**4.1 MEASUREMENT**

A. The quantities of accepted work will be measured in the following units. All measurements will be plan measure except for authorized changes.

1. Description: Lump Sum

4.2 PAYMENT

A. Payment will be made at the respective unit or lump-sum price listed in the proposal and shall be full compensation for all labor, materials, and equipment necessary to complete the respective unit in place. There will be no separate measurement or payment for any item of work not specifically identified and listed in the proposal, and all such work shall be considered a subsidiary item with all costs pertaining thereto included in the prices for other items listed in the proposal. At the Engineer's option, partial payment may be made for any lump sum item listed in the proposal, providing that the Contractor is diligently and satisfactorily pursuing full completion of such partially complete item in accordance with the approved job progress schedule.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 34 23 90**OCS INSTALLATION RECORDS****PART 1 - GENERAL****1.1 SUMMARY**

- A. This Section covers the requirements for OCS installation records at site specific OCS support locations including As-built Structure Record Drawings, OCS Wiring Layout Redline Drawings, OCS Materials List, Assembly "Used-on" List, Conductor Stringing Records, Cantilever Cutting Dimension Sheets and Test Reports.
- B. All electronic media shall be developed with a software format agreed to by the Engineer.

1.2 RELATED SECTIONS

- A. SECTION 01 33 00 – Submittal Procedures
- B. SECTION 34 23 96 – OCS Installation and Maintenance Manuals

1.3 SUBMITTALS

- A. Submittals shall be made in accordance with the requirements of SECTION 01 33 00 – Submittal Procedures, except as modified herein.
- B. Samples of each type of OCS installation record shall be submitted to the Engineer within 60 days of Notice to Proceed.
- C. The first submittal of the As-built Structure Record Drawing shall be made in three drawing sets, clamped or bolted together, 11 x 17 inch size for review and comment by the Engineer.
- D. Final copies of the As-built Structure Record Drawing and Materials List shall be three copies 11 x 17 inch size in 7-ring binders or an Approved equal
- E. The final submittal of OCS Wiring Layout red-line "as-built" drawings shall be stamped "Project Record", signed and dated by the Contractor, and shall be delivered to the Project Manager prior to the final inspection.
- F. In addition to the requirements for hard copies of Contractor originated drawings, final copies of As-built Structure Record Drawings and Materials Lists shall be submitted in electronic format which shall include a matrix or document showing how the files are set up and how to access them. Include no extraneous files. Two CD ROMs shall be submitted.
- G. Two copies of Conductor Stringing Records and Cantilever Cutting Sheets shall be submitted to the Engineer.

PART 2 - PRODUCTS**2.1 AS-BUILT STRUCTURE RECORD DRAWINGS**

As-built Structure Record Drawings show the OCS as-built conditions at each location (stationing) where Work was performed by the Contractor.

- A. The Contractor shall provide an As-built Structure Record Drawing for each OCS pole.

- B. The Contractor originated drawings shall be developed in accordance with the Contract Drawings, and will show a photographic image of the final conditions at each location.
- C. The photographic image of the OCS poles shall depict the elevation taken from centerline of track, or thereabouts, facing in the direction of increasing stationing, and include the track rails and the complete structure and its constituent assemblies.
- D. Each structure photograph shall have an image that broadly fills the height of the available space on the As-built Structure Record Drawing.
- E. All photographs shall be taken at the highest quality and resolution level available on digital camera with at least 5.0 mega pixels capable of saving photographs on a non-glossy format like "TIFF".
- F. "Design" data (values and references) and "installed" data shall be shown in separate columns.
- G. Each column of data shall be for an individual wire run.
- H. The installed values for contact wire heights and staggers at supports shall be as measured by height and stagger gauge after remedial work has been completed.

2.2 OCS WIRING LAYOUT REDLINES

- A. The Engineer will furnish to the Contractor a complete set of OCS Wiring Layouts Drawings for redline purposes.
- B. The Contractor shall red-line the Wiring Layout Drawings to show any changes to the assembly references on a structure by structure basis. Wire heights and stagger values shall not be changed except at the direction of the Engineer.

2.3 OCS MATERIALS LIST

- A. The Contractor's proposed format of the computer generated Materials List and the "Used-on" List shall be forwarded to the Engineer prior to the submittal of the final documents.
- B. Assembly references given on Wiring Layout Drawings shall be totaled by computer and issued by the Contractor in tabular form as follows:

1. Materials List

By site specific OCS pole/OCS support location (stationing) showing every assembly required for complete installation of the support and of the span ahead

2. "Used-on" List

By assembly reference, showing every support location (stationing) where the specific assembly is used

2.4 OCS CONDUCTOR STRINGING RECORDS

- A. For each length of conductor installed, a detailed record shall be kept of:
 1. The reel number from which the conductor was taken
 2. The maximum prestressing tension applied
 3. The temperature at the time of tensioning

4. The time period that the prestressing was applied
5. Final installation tension and conductor temperature
6. Certifying signature of the Contractor's Superintendent/Engineer/Construction Manager

2.5 CANTILEVER CUTTING SHEETS

- A. For each cantilever, the dimensions of the pipes and other components shall be shown on Cantilever Cutting Sheets.

2.6 TEST REPORTS

- A. Test Reports initiated by the Contractor or by the Engineer and prepared by the Contractor shall be treated in accordance with SECTION 01 33 00 – Submittal Procedures.

PART 3 - EXECUTION

Not Used

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

- A. The quantities of accepted work will be measured in the following units. All measurements will be plan measure except for authorized changes.
 1. Description: Lump Sum

4.2 PAYMENT

- A. Payment will be made at the respective unit or lump-sum price listed in the proposal and shall be full compensation for all labor, materials, and equipment necessary to complete the respective unit in place. There will be no separate measurement or payment for any item of work not specifically identified and listed in the proposal, and all such work shall be considered a subsidiary item with all costs pertaining thereto included in the prices for other items listed in the proposal. At the Engineer's option, partial payment may be made for any lump sum item listed in the proposal, providing that the Contractor is diligently and satisfactorily pursuing full completion of such partially complete item in accordance with the approved job progress schedule.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 34 23 96**OCS INSTALLATION AND MAINTENANCE MANUALS****PART 1 - GENERAL****1.1 SUMMARY**

- A. This Section describes the Work and format required to produce Overhead Contact System (OCS) Installation and Maintenance (I&M) Manuals.
 - 1. All OCS I&M manuals shall comprehensively address Overhead Contact System assembly configurations, assembly/component maximum loads, OCS installation precautions, conductor stringing, initial creep removal, final adjustments, preventive maintenance, servicing, repair and spare parts provisioning. Include information for routine OCS inspections and quantitative OCS measurements. Include OCS assembly replacement procedures with the OCS energized and de-energized.
 - 2. OCS I&M Manuals shall be prepared in separate sections addressing:
 - a. OCS wiring and poles
 - b. OCS shop drawings, assembly references, components and conductors
 - c. Spare parts catalogs
 - d. OCS disconnect switches

1.2 RELATED SECTIONS

- A. SECTION 01 33 00 – Submittal Procedures
- B. SECTION 34 23 97 – OCS Maintenance Staff Training

1.3 QUALITY ASSURANCE

- A. Provide qualified manual writers and developers who are thoroughly familiar with all subject material for each volume.

1.4 SUBMITTALS

- A. Submittals shall be made in accordance with the requirements of SECTION 01 33 00 – Submittal Procedures, except as modified herein.
- B. The Contractor shall submit the following:
 - 1. One complete photo-ready reproducible hard copy of each volume of the I&M Manual.
 - 2. One all-electronic media version of the complete manual on compact disc using MS Windows compatible files in a software format mutually agreed upon with the Engineer.
 - 3. Electronic media versions revised in accordance with hardcopy manual revisions, during the review period
 - 4. Submit five copies of I&M Manuals in final form.

1.5 SUBMITTAL SCHEDULE

- A. The Contractor, at a minimum, shall submit to the Engineer for Approval the following, in accordance with the following timetable:
1. OCS I&M Manual Outline – Submit two sets of manual outlines with a submittal schedule to the Engineer for Approval, at least 1 year before the start of the prescribed training courses specified in SECTION 34 23 97 – OCS Maintenance Staff Training.
 2. OCS I&M Manual, Draft - Submit two sets of the first draft of the proposed training materials 6 months before the start of the prescribed agency training course.
 3. OCS I&M Manual Training Draft - Submit ten sets of the training draft for use during the training class, 30 days before the start of the prescribed agency training course.
 4. OCS I&M Manual, Final - Submit final volumes of the I&M Manuals in the following quantities 30 days after the completion of training:
 - a. Three complete sets of manuals in reproducible hard copy format
 - b. One electronic copy in native format
 - c. One electronic copy in Adobe PDF format
 5. The final submittal of materials shall correct all errors that were found by the Contractor, during training or changes that were requested by the Engineer.
- B. All revision updates for all volumes of the OCS I&M Manual shall be provided to the Engineer by the end of the Warranty period or more frequently to reflect any changes made to the OCS during the Warranty period.

1.6 MANUAL CONTENT

- A. The I&M Manual shall cover, but not be limited to the following OCS topics:
1. Overhead Contact System description
 2. Section insulators
 3. Disconnect switches
 4. Poles
 5. Surge arresters
 6. Cantilever assemblies
 7. Headspan assemblies
 8. Single wire cross span assemblies
 9. All splice types
 10. Maintenance and inspection special tools
 11. Operations and Maintenance Procedures
 12. Safety Precautions

PART 2 - PRODUCTS**2.1 MANUAL FORMAT**

- A. Manuals shall consist of 8 1/2 x 11 inch sheets bound in loose-leaf 7-ring type binders. Binders shall not exceed 3 inches overall thickness. Several binders may be required.
 - 1. Foldout diagrams or illustrations may be employed with a maximum size of 11 x 17 inches. The title shall be visible when the sheet is folded.
 - 2. Covers shall be oil, grease, solvent and wear resistant.
 - 3. The paper and ink shall resist smearing, fading and deterioration from age.
- B. The organization of the manuals shall treat the OCS as a system and not as a grouping of disassociated parts. The manuals shall highlight the precautions to be taken by operating and service personnel to assure their safety while performing maintenance, and servicing functions.
- C. Manuals shall be written in English to be understood by a high school graduate with 2 years of experience in a related field but with minimal knowledge of railroad or transit operations. The writing shall be concise and free of ambiguities.
- D. Manufacturer's standard manuals and parts lists will be acceptable, subject to the approval of the Engineer, if they deviate only slightly from the requirements specified herein.
- E. Revisions to a manual shall be reflected in a revision index, which shall form an integral part of each manual and which shall be revised with each manual update.
- F. Diagrams and illustrations shall not be loose or in pockets. All printed material shall be clearly reproducible by copying machines, which precludes the use of halftone illustrations (line drawings are required).
- G. The material in the manuals including the spare parts catalogs shall be similarly organized and indexed, with a standard numbering system. The format of all data contained in the manuals shall be consistent section to section.

2.2 PURPOSE

- A. The OCS I&M Manual shall enable the maintenance staff to have, in convenient form, all information needed for preventive maintenance inspections, maintenance tasks, adjustment and installation, and on-site trouble diagnosis.
- B. It shall also contain a detailed description of each system component so that the maintenance staff can effectively service, inspect, maintain, adjust, troubleshoot, repair and replace it.
- C. An integrated set of OCS shop drawings shall be included as a separate section. All portions of the drawings shall be legible when printed on 8 1/2 x 11 inch paper.
- D. Include in the manual:
 - 1. General description
 - 2. Principles of operation
 - 3. Shop drawings to component level
 - 4. A conductor schedule listing installation details of every contact wire by wire run number

5. Preventive maintenance tasks and procedures highlighting critical areas requiring meticulous attention for inspection and maintenance standards including wear limits, settings and tolerances
6. Lubrication and cleaning, including frequency, methods, and trade identifications of recommended materials, component location and description
7. Summarized preventive maintenance schedules and recommended intervals
8. Repair procedures including dismantling, reassembly and testing procedures
9. Requirements of special tools, jigs, stagger and clearance gauges and their source of supply
10. Test equipment lists and their description
11. Spare parts requirements
12. Warning and safety procedures during maintenance actions
13. A description of OCS assemblies and assembly references
14. Standard installation procedures
15. Safety procedures
16. List of special tools that are required for any given installation
17. Any other information necessary to ensure proper installation and as required by the Engineer

2.3 SPARE PARTS CATALOG

- A. The spare parts volume of the I&M Manual shall catalog, enumerate, and describe every component with its related parts and necessary special tools, including the supplier's number and any commercial equivalents.
- B. Drawings shall identify all sub-assemblies and component parts. A component part is defined as the lowest level of component assembly that consists of a separate individually fabricated part.
- C. Parts common to different components (e.g. bolts and nuts) shall bear the same Contractor's number in all components with a reference to the other components in which they are used. Each part or other component shall be identified as being part of the next higher assembly.
- D. Commonly available material such as galvanized pipe, galvanized and stainless steel wires and rods, nuts and bolts, thimbles etc. shall be identified by standard hardware nomenclature and the Contractor's number. A separate list of these items shall be provided in the manuals with information sufficient to order these items through (local) commercial channels.
- E. The spare parts catalog shall have a complete itemization of all consumable parts and servicing materials (oils, paints, special compounds, grease, etc.) required for the component requiring its use.
- F. Federal Paint Registry Numbers shall be supplied in addition to paint descriptions as part of the itemization of consumables

- G. In addition to the normal cross-referencing noted in the preceding paragraphs, at least three supply sources shall be provided for all required consumables and servicing materials. Suppliers and materials shall be specified by trade name and type. Of the three required sources, at least two shall be located in the United States

PART 3 - EXECUTION

Not Used

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

- A. The quantities of accepted work will be measured in the following units. All measurements will be plan measure except for authorized changes.
1. Description: Lump Sum

4.2 PAYMENT

- A. Payment will be made at the respective unit or lump-sum price listed in the proposal and shall be full compensation for all labor, materials, and equipment necessary to complete the respective unit in place. There will be no separate measurement or payment for any item of work not specifically identified and listed in the proposal, and all such work shall be considered a subsidiary item with all costs pertaining thereto included in the prices for other items listed in the proposal. At the Engineer's option, partial payment may be made for any lump sum item listed in the proposal, providing that the Contractor is diligently and satisfactorily pursuing full completion of such partially complete item in accordance with the approved job progress schedule.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 34 23 97**OCS MAINTENANCE STAFF TRAINING****PART 1 - GENERAL****1.1 SUMMARY**

- A. This Section includes Specifications for training materials, training programs and training schedules for the Overhead Contact System (OCS).
1. The Contractor shall complete all OCS training 30 days prior to the start of OCS Commissioning.
 2. Training classes shall be for OCS trainees between entry level and Journeyman.
 3. The Contractor shall furnish manuals, training literature and training aids for OCS training.
 4. Training and support materials shall be provided to enable the agency personnel to operate and maintain the complete OCS. The training program shall include detailed instructions, demonstrations and supervised hands-on training.
 5. Each OCS trainee class shall be given twice. The Contractor shall coordinate with the Engineer during the scheduling of the training classes so that the agency only has to provide 50% of the OCS maintenance/operations staff at any one given time. Depending on the agreed upon schedule, the duplication requirements for classes may require a periodic gap of time between classes.
 6. Each class shall be developed with the Engineer, with the objective of the agency being able to repeat training for OCS trainees at a later date.
 7. All training shall be given in English, unless otherwise requested/coordinated by the Owner.
 8. The agency shall retain the right to reproduce any of the training materials for its own use.

1.2 RELATED SECTIONS

- A. SECTION 01 33 00 – Submittal Procedures
- B. SECTION 34 23 90 – OCS Installation Records
- C. SECTION 34 23 96 – OCS Installation and Maintenance Manuals

1.3 DESCRIPTIONS

- A. Element – A Systems Element, i.e., OCS, Communications, Corrosion, Signals or Traction Power
- B. Topic – A subject area within OCS, for which instruction will be completed in less than 4 hours.
- C. Instructor – A Contractor's employee nominated to give training
- D. Trainee – An agency employee receiving training
- E. Agency OCS Trainers – An agency employee selected to teach trainees

- F. Student – A trainee or agency OCS Trainers attending a class of instruction
- G. OCS Training Materials – This describes the OCS documents used in support of the classroom and workshop instruction, and comprises:
 - 1. OCS Instructors Training Guide
 - 2. OCS Training Aids
 - 3. OCS Student Workbooks
 - 4. OCS Trainers Handbook
- H. OCS Support Materials – As-built documentation of the installed OCS, including updated Contract Drawings, acceptance measurements forms, cantilever cut sheets, Structure Record Drawings of every OCS support and the OCS I&M Manuals.
- I. OCS Instructors Training Guide – Used as a manual by OCS Instructors and the agency OCS trainers, this Guide includes a course outline, agendas, objectives, lesson plans, training aids, presentation guidelines, suggested questions for class discussion, and criteria for measuring student performance.
- J. OCS Training Aids include:
 - 1. Visual displays (overhead transparencies, Power Point files)
 - 2. OCS assemblies and components
 - 3. Scale models
 - 4. Mock ups
 - 5. Tools and equipment
- K. OCS Student Workbooks – These workbooks for trainees include a course agenda, a schedule of sessions, hard copies of presentations (e.g. transparencies, electronic presentation files), lecture outlines, and any additional printed material used during the course.
- L. OCS Trainers Handbook – This Handbook for OCS Trainers expands on the subject matter given in the Instructors Training Guide by showing additional examples, photographs, charts and tables. Answers to questions on aspects of OCS raised by the trainees in previous classes are included. The OCS Trainers Handbook also gives assistance in the use of training aids provided by the Contractor.
- M. OCS Installation and Maintenance Manual – typically comprising sections on pole and wiring installation, shop drawings, OCS spare parts and details on disconnect switches.

1.4 TRAINING

- A. Training shall be conducted at the agency facilities in Kansas City, Missouri and include classroom and hands-on instruction for agency personnel.
- B. The size of OCS trainee classes, time and location for the training shall be Approved in advance by the Engineer.
- C. Instructors shall conduct customized training classes on OCS topics.
- D. Instructors shall be capable of providing detailed explanations of the operation and maintenance of all aspects of OCS, including individual assemblies, and of answering any questions that may arise.

- E. The Contractor shall furnish experienced instructors who have direct knowledge of OCS.
- F. For each class, Instructor(s) shall have previously conducted classes of similar subject matter and scope, and shall be proficient in the use of the tools, equipment and training aids.
- G. The resumes and qualifications of OCS instructors shall be submitted to the agency for Approval.
- H. A list of the OCS topics to be taught by each instructor shall be submitted in advance to the Engineer.
- I. All instructors shall be fluent in English. Prior to the initiation of classroom instruction, all instructors nominated by the Contractor shall attend a 1-day orientation at the agency to become familiar with agency safety regulations and facilities, and to be advised of student qualifications and expectations.
- J. The Contractor shall furnish a description of the prerequisite knowledge trainees must have before starting OCS training classes.

1.5 SUBMITTAL QUANTITIES FOR FINAL OCS TRAINING MATERIALS

- A. The Contractor shall provide the following final training materials:
 - 1. One complete photo-ready reproducible set of OCS Instructor Training Guide, OCS Trainers Handbook, and Student Workbook
 - 2. All training materials that are produced for the Project shall be MS Windows compatible files, using a software format mutually agreed between the Engineer and the Contractor. The electronic media versions shall be revised in accordance with the hardcopy manual revisions.
 - 3. Two OCS Instructors Training Guides
 - 4. Two OCS Trainers Handbooks
 - 5. One complete set of training aids
 - 6. Ten student workbooks
- B. A schedule for delivery of training materials to all designated the agency personnel shall be approved in advance by the Engineer.

1.6 SUBMITTAL SCHEDULE

- A. The Contractor, at a minimum, shall submit to the Engineer for Approval, in accordance with SECTION 01 33 00 – Submittal Procedures, OCS Training Outline Proposals and OCS Training Materials, in accordance with the following timetable:
 - 1. OCS Training Outline Proposals – Submit two sets of training outlines/schedules. The outline/schedule shall be submitted to the Engineer for Approval, at least 1 year before the start of the prescribed agency training courses.
 - 2. OCS Training Materials, Draft - Submit two sets of the first draft of the proposed training materials 6 months before the start of the prescribed agency training course.
 - 3. OCS Training Materials, Training Draft - Submit ted sets of the training draft for use during the training class, 30 days before the start of the prescribed agency training course.

4. OCS Training Materials, Final - Submit final training materials in the following quantities 30 days after the completion of training:
 - a. Three complete sets of manuals in reproducible hard copy format
 - b. One electronic copy in native format
 - c. One electronic copy in Adobe PDF format
 5. The final submittal of training materials shall correct all errors that were found by the Contractor, found during training or changes that were requested by the Engineer.
- B. All revision updates for all the training materials shall be provided to the agency by the end of the Warranty period or more frequently to reflect any changes made to the OCS during the Warranty period.

1.7 INSTRUCTION REQUIREMENTS

- A. Trainees shall be exposed to the depth of detail that is necessary for the performance of preventive, corrective, overhaul and maintenance operations for all OCS equipment supplied under this Contract.
- B. Trainees shall be afforded the opportunity to perform the more complex maintenance functions in the field and in the shop, in addition to troubleshooting faults artificially introduced in the equipment.
- C. Instruction shall include, at a minimum, the following:
 1. Introduction to the equipment, including terminology, and the identification of OCS assemblies
 2. The OCS Wiring Layouts drawings showing the configuration of the OCS over the tracks
 3. Theory of design of an OCS.
 4. Routine care, including cleaning, lubrication schedules, adjustments and inspection criteria
 5. Problem symptoms, troubleshooting techniques and repair procedures
 6. Removal and replacement of components
 7. Disassembly and reassembly for the purpose of component familiarity and any special processes
 8. When methods of access, removal, dismantling, or application are not self-evident, the instruction shall cover these matters
 9. Instruction in the use and maintenance of all OCS special tools and gauges
 10. Safety instruction for all maintenance activities
 11. Overhaul procedures

1.8 TRAINING OUTLINES

- A. The Contractor shall develop and provide a training outline proposal for agency Approval 1 year in advance of the scheduled training.

- B. The Contractor training outline shall include:
1. A list of OCS training topics
 2. A detailed outline of each topic
 3. A description of the scope of instruction to be covered in each topic
 4. An overview of the hands-on experience to be included as a part of the OCS training course
 5. A list of the OCS equipment, tools and test equipment, manuals, and other materials to be utilized as trainee training aids
 6. Lesson plans that include the sequence of activities, an outline of the content, the learning strategies to be used (e.g., classroom presentation, hands-on practice, audio/video presentation, etc.), and include sample lessons
 7. An assessment of the classroom space, workshop space and power supplies needed for training
 8. A list of classroom equipment that agency might loan if requested
 9. The duration of the training, in hours, for each topic, broken down into classroom, workshop and fieldwork
 10. A proposed course schedule

1.9 OCS TRAINING MATERIALS

- A. Training materials shall be separate and distinct from the Contract As-built records and I&M Manuals. Training materials shall be setup to contain step-by-step introduction to the OCS training classes and shall describe those features and equipment peculiar to OCS.
- B. As training materials are being developed, the Contractor shall work closely with agency staff, to ensure the specified agency standards with respect to the course organization, content, and overall quality of all training materials are being met.
- C. The Contractor shall provide an adequate supply of high quality, professionally prepared training material on paper, and such other training aids as described in this Section, to impart the essential knowledge to the trainees involved and leave them with authoritative and up-to-date reference material.
- D. Training materials shall provide support to the training courses, and comprise the OCS Instructors Training Guide, OCS training aids, and OCS student workbook.

1.10 OCS INSTRUCTORS TRAINING GUIDE

- A. The Contractor shall provide Instructors Training Guides for Contractor's instructors and for agency OCS trainers, containing course outline, agendas, objectives, lesson plans, training aids, presentation guidelines, suggested discussion questions and criteria for measuring student performance by a series of tests.
- B. The information given in the Instructors Training Guide shall be coordinated with course information and course materials, and shall be grouped to correspond to course periods of not more than 4 hours.
- C. Written and practical tests shall be included, that are to be given at suitable points during training. These tests shall be designed to determine the extent to which students have learned and can apply the information presented.

1.11 TRAINING AIDS FOR OCS TRAINEE CLASSES

- A. The Contractor shall provide training aids for use by the OCS instructor, such as mock-ups, scale models, and electronic presentations (e.g. Microsoft Power Point files) etc. The following materials may be used as training aids:
1. Items that are ear-marked for spare parts may be used to facilitate hands-on-training in a workshop setting or out on the line.
 2. OCS assemblies such as section insulators, shop-door bridges, surge arresters, disconnect switches and pantographs, the functions of which can be displayed without dismantling.
 3. Electronic presentation files (software format to be approved by agency or videos shall be used for training aids. Electronic presentation files may be used to illustrate OCS assemblies showing components, and OCS wiring layouts.
 4. Lesson plans shall be updated as required during the course of instruction.
- B. All training aids shall be of durable construction and shall become the property of the agency. Any equipment or tools used during training are in good working condition both before and after training sessions.
- C. All training materials, such as training aids and lesson plans, shall become the property of the agency at the completion of the training program. The Contractor shall be responsible for the condition of these materials for the duration of the training program.
- D. Where videos are used for instruction, one copy of each instructional video shall be provided to the agency on a DVD.
- E. Course materials (e.g. manuals, class handouts, tools, equipment, videos, computer-based software) and training materials shall be provided for each class, and shall be reusable (where practical). The same training materials shall be used for each class so that each class is exposed to the same information and comments can be collected on training manuals. Comments from training manuals will be given to the Contractor for incorporation into the final manuals.

1.12 OCS STUDENT WORKBOOKS

- A. The Contractor shall provide student workbooks for OCS trainees that include:
1. Course objectives
 2. A course agenda
 3. Schedule of sessions
 4. Lecture outlines
 5. Instructions on use of course materials, tools, equipment and other instruction aids
 6. Notebook-size, 8 1/2 x 11 inch, copies of all visual displays used by an instructor, (e.g. electronic presentation files)
- B. The student workbook shall include prepared notes on:
1. Design and operation of the OCS
 2. The interaction between OCS and other System Elements, such as traction power, signals and corrosion

3. Civil trackwork, overhead bridges and underpasses impacting the design and maintenance of the OCS
 4. The relationship of the OCS wiring layouts and the assembly reference drawings/shop drawings
 5. Contract OCS as-built drawings and other installation records
 6. The content and use of the procedures in the OCS I&M Manuals
 7. OCS test equipment
 8. The calibration and regular checking of stagger gauges and clearance envelope carts
 9. Use and analysis of Acceptance measurements sheets
 10. Hook-up video equipment for OCS surveillance runs
- C. Student workbooks shall be retained by the trainees for future reference.
- D. Student workbooks shall be printed single sided and presented in 3-ring binders. This will allow room for students to use the blank sides of pages for notes.

1.13 OCS CONTRACT DRAWINGS

- A. OCS Contract Drawings include both basic design drawings and site-specific drawings. On completion of the installation these drawings are updated to an As-built or a Design Update condition.
1. For use in class (in the absence of screen projection) these drawings shall be reproduced in two sets: a BASIC DESIGN set and a SITE-SPECIFIC set at 11 x 17 inch size.
 2. For distribution to each trainee the two sets shall be reproduced at 8 1/2 x 11 inch and comb-bound.

1.14 OCS INSTALLATION AND MAINTENANCE MANUALS

- A. I&M Manuals, (also called Installation and Maintenance Manual), typically comprise the following volumes:
1. OCS wiring and poles
 2. OCS shop drawings, assembly references, components and conductors
 3. Spare parts catalogs
 4. OCS disconnect switches
- B. These volumes shall be available for training purposes, and such a set shall be made available to the training class. See SECTION 34 23 96 – OCS Installation and Maintenance Manuals.

1.15 AMOUNT OF REQUIRED TRAINING TIME FOR OCS TRAINEES

- A. The Contractor shall designate the total number of hours allocated for training of two classes with a class size of up to ten people.
- B. Based on this, the Contractor shall provided two classes at up to ten agency employees per class for OCS training at 40 hours for each class = 80 hours total for OCS training.

1.16 TRAINING SYLLABUS FOR THE TRAINEES COURSE

- A. The Contractor shall develop a course syllabus covering the following topics and allowing time for the trainees to interact with the Instructor during the instruction by asking questions and receiving input based on real life experiences. Where appropriate the instructor shall address typical misinterpretations by novices of criteria and of equipment factors of safety. Showing of Video/DVD recordings is encouraged. Field visits shall be included where practical. Time for short written tests during class time shall be allowed.
- B. The following shall provide a framework for the order of the topics to be taught and times shown are typical values and may be varied, but the sequence of the classes and their duration is at the Contractor's choice, but subject to the Engineer's Approval:
1. Introduction to OCS (class room)
 - a. Glossary of OCS Terms
 - b. Description of OCS styles
 2. OCS Design Basis (class room and field)
 - a. Agency Design Criteria (all Sections)
 - b. Streetcar Characteristics
 - 1) Vehicle envelopes
 - 2) Pantographs
 - 3) Pantograph clearance envelopes
 - c. Conductors and wires
 - 1) Types and uses
 - 2) Tensions and sags
 - d. Contact wire stagger design
 - 1) Track tolerances
 - 2) Vehicle and pantograph sway
 - 3) Wind effects
 - 4) Mid-span offset
 - e. Contact Wire Height
 - 1) In streets and segregated right-of-way (ROW) (NESC)
 - 2) Clearance at overpasses
 - 3) Track sags and hogs
 - 4) Contact wire gradients

-
- f. Clearance Criteria
 - 1) Electrical
 - 2) Physical (Code)
 3. As-built Records, as described in SECTION 34 23 90 – OCS Installation Records.
 - a. OCS Contract Design Update Drawings (class room)
 - 1) Drawing hierarchy
 - 2) Basic design drawings
 - 3) Site specific drawings
 - b. OCS Testing and Measurements Records (class room and field)
 - 1) OCS acceptance measurements
 - 2) Pole ground resistance measurements
 - 3) Pantograph clearance envelope checks
 - 4) Streetcar OCS videotapes
 - 5) Structure record drawings
 4. Installation and Maintenance Manuals (I&M), as described in SECTION 34 23 96 – OCS Installation and Maintenance Manuals (class room)
 - a. OCS wiring and poles
 - 1) Conductor stringing
 - 2) Preventive maintenance
 - b. OCS shop drawings, components and conductors
 - c. OCS parts catalog
 - d. OCS disconnect switch
 5. Shop Work
 - a. Cantilever manufacture
 - b. Pull-off assembly
 - c. Hanger manufacture
 - d. Other assemblies
 6. Periodic Inspections of the OCS
 - a. Quantitative Measurements (class room and field)
 - 1) Wire heights and staggers
 - 2) Track elevation and superelevation
 - 3) Analysis of height and stagger measurements

- b. Qualitative Inspections (class room and field)
 - 1) Eye-level inspections
 - 2) Ground-level inspections
 - 3) OCS surveillance by video
- 7. Reasons for OCS Line Failures (class room)
 - a. Dewirements
 - b. Lightning strikes
 - c. Vandalism
 - d. Faulty materials
- 8. Hi-Rail Vehicles (class room and field)
 - a. Use
 - b. Maintenance
- 9. OCS Tools, Equipment and Gauges (class room and field)
 - a. Stagger gauges
 - b. Pantograph clearance gauge
 - c. Video equipment
 - d. Tensiometers
 - e. De-kinking tools
 - f. Lifting equipment and slings
 - g. Work/worker safety
- 10. Agency Operations and Maintenance Procedures (class room)

1.17 SPECIAL EQUIPMENT FOR OCS TRAINING CLASSES

- A. The Contractor shall, at a minimum, supply one complete set of all special tools and test equipment necessary to service, repair, maintain, and overhaul each system shall have been delivered by the Contractor for use in the training program. At the completion of the training program these special tools, test equipment, and training aids shall be turned over to the Engineer, in proper working order, by the Contractor.

PART 2 - PRODUCTS

Not Used

PART 3 - EXECUTION

Not Used

PART 4 - MEASUREMENT AND PAYMENT**4.1 MEASUREMENT**

A. The quantities of accepted work will be measured in the following units. All measurements will be plan measure except for authorized changes.

1. Description: Lump Sum

4.2 PAYMENT

A. Payment will be made at the respective unit or lump-sum price listed in the proposal and shall be full compensation for all labor, materials, and equipment necessary to complete the respective unit in place. There will be no separate measurement or payment for any item of work not specifically identified and listed in the proposal, and all such work shall be considered a subsidiary item with all costs pertaining thereto included in the prices for other items listed in the proposal. At the Engineer's option, partial payment may be made for any lump sum item listed in the proposal, providing that the Contractor is diligently and satisfactorily pursuing full completion of such partially complete item in accordance with the approved job progress schedule.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 34 42 10**SIGNALS GENERAL ENGINEERING AND DESIGN REQUIREMENTS****PART 1 - GENERAL****1.1 SUMMARY**

- A. This Section includes Specifications for general engineering and design requirements applicable to all portions of the Work unless otherwise specified. It also includes definitions, general requirements and Standards and Codes. This Section also details submittal requirements. The Contractor shall, in conformance with the Contract Documents
1. Design the Signal System
 2. Manufacture the Signal System
 3. Install, adjust and test the Signal System
 4. Provide spare parts, special tools and test equipment
 5. Furnish documentation and drawings necessary to support operation, maintenance and repair of the Signal System
 6. Provide technical support to verify the proper operation of the Signal System
 7. Train the Agency personnel in the operation and maintenance of the Signal System and provide training aids and materials for future use as described in the Contract Documents
 8. Provide technical support and replacement parts during the warranty period
- B. These documents are intended to establish and control both the specific and general design parameters for the design, fabrication, installation and testing of the Street Car Signal System for the use on the Project. The use of proven equipment and designs is required.

1.2 RELATED SECTIONS

- A. SECTION 01 33 00 – Submittal Procedures
- B. SECTION 01 43 00 – Systems Quality Assurance
- C. SECTION 34 42 16 – Signals Wire and Cable
- D. SECTION 34 42 29 – Signals Electrical and Electronic Components
- E. SECTION 34 42 76 – Signals Tests and Inspections

1.3 QUALITY ASSURANCE

- A. The Contractor shall comply with the requirements of Division 11.
- B. Failsafe equipment proposed for this Contract shall have been proven by in-service experience.

1.4 DEFINITIONS

- A. The Street Car signal portions of the Contract Documents use terms that are specific to the railroad signal industry. Whenever the following railroad signal terms appear in these Specification Sections they shall be interpreted as follows.
- B. AAR Terminals – Terminal blocks which conform to AREMA Communications and Signals Manual Part 14.1.8 (Recommended Design Criteria for Molded Binding Post Type Terminal Block, Details & Assemblies)
- C. Absolute Block – A block in which no train is permitted to enter while it is occupied by another train
- D. Approach Lighting – A method of lighting signals upon the approach of a train
- E. Approach Locking – Electric locking is effective while a train is approaching within a specified distance. Approach locking is arranged such that a signal displaying an aspect to proceed, and which prevents, until after the expiration of a predetermined time interval after such signal has been caused to display its most restrictive aspect, the movement of any interlocked or electrically locked switch, movable point frog, or derail in the route governed by the signal, and which prevents an aspect to proceed from being displayed for any conflicting route
- F. Aspect – The appearance of a fixed signal conveying an indication as viewed from the direction of an approaching train
- G. Automatic Block Signal System – A series of consecutive blocks governed by block signals. ABS system is actuated by a train, engine, or by certain conditions affecting the use of a block
- H. Block – A length of track of defined limits, the use of which trains and engines are governed by block signals, cab signals or both
- I. Conflicting Movements – Movements over conflicting routes
- J. Conflicting Routes – Two or more routes opposing, converging or intersecting, over which movements cannot be made simultaneously without possibility of collision
- K. Current of Traffic – The direction specified by the operating rules in which trains may move on a designated track
- L. Detector Locking – A method of locking which is effective when the detector track circuit (OS) is occupied. Detector Locking prevents the operation of any power operated switch, moveable point frog, or derail and the display of any signal indication more favorable than Proceed at Restricted Speed within the limits of the detector track circuit. Detector Locking is also referred to as Section Locking
- M. Electric Locking – The combination of one or more electric locks and controlling circuits by means of which levers of an interlocking machine are locked, or the equivalent using circuits only, so that switches, signals, or other units operated in connection with signaling and interlocking, are secured against operation under certain conditions.
- N. Failure – An improper condition resulting from a device not performing its intended function
- O. Failure Rate – The frequency of failure, expressed as failures per hour, failures per mile, etc. Failure rate is the mathematical reciprocal of Mean Time Between Failures (MTBF)
- P. In Advance of Signal – A term used in defining the territory beyond a signal as seen from an approaching train

- Q. In Approach to a Signal – A term used in defining the territory to which a signal indication is conveyed
- R. Indication – The information conveyed by the aspect of a signal
- S. Indication Locking – Electric locking which prevents manipulation of levers that would result in an unsafe condition for a train movement if a signal, switch or other operative unit fails to make a movement corresponding to that of its controlling lever, or which directly prevents the operation of a signal, switch or other operative unit, in case another unit which should operate first fails to make the required movement
- T. Interface – The points where two or more systems, subsystems or structures meet, transfer energy or transfer information
- U. Interlocked Switch – A track switch within the interlocking limits, the control of which is interlocked with other functions of the interlocking
- V. Interlocking – An arrangement of signals and signal appliances so interconnected that their movements must succeed each other in proper sequence and for which interlocking rules are in effect. It may be operated manually or automatically
- W. Mean Time Between Failures (MTBF) – The mean operating time between independent failures
- X. Non-vital Circuit – Any circuit the function of which does not affect the safety of train operation
- Y. Reliability – The probability of performing a specified function without failure and within design parameters for the period of time intended under actual operating conditions
- Z. Route – The course or way to be traveled
- AA. Route Locking – Electric locking, effective when a train passes a signal displaying an aspect for it to proceed, which prevents the movement of any switch, movable point frog, or derail in advance of the train within the route entered. It may be so arranged that as a train clears a track section of the route, the locking affecting that section is released
- BB. Safe – The condition in which passengers, crew, or repair personnel are secure from threat, danger, harm, or loss arising from improper design, manufacture, assembly, malfunction or failure of the signal system or any of its components or subsystems
- CC. Speed, Schedule – The average speed of a vehicle or train, from terminal to terminal obtained by dividing the distance between these points by the time taken to make the trip including time for intermediate station stops
- DD. Switch Machine – A device, the complete operation of which performs the three functions of unlocking, operating and locking a switch
- EE. Tight (used as a suffix) – Apparatus is designated as watertight, dust tight, etc., when so constructed that the enclosing case excludes the specified material
- FF. Train – One or more cars coupled together and operating as a unit
- GG. Vital Circuit – Any circuit and its elements, the function of which affects the safety of train operations

1.5 GENERAL REQUIREMENTS

- A. The intent of the Project is to procure a signal system based on components and designs, which have a proven performance history. This Section provides information considered pertinent to the understanding of the Street Car environment. The Signal System shall include:
1. General Streetcar operations
 - a. Exiting Non-Revenue tracks and Entering into Revenue Service
 - 1) All street car vehicle operations entering or leaving the mainline will need to be coordinated by operations dispatch. Contractor to coordinate streetcar signals design with traffic signal design.
 - 2) A streetcar exiting the on the Shop Track towards the mainline Northbound Track on Grand Boulevard for revenue service operation will position itself over the L2 Train-to-Wayside (TWC) loop located adjacent to the S2 bar signal at the intersection of Grand Boulevard and West 3rd Street. The streetcar operator will look to see if there is a streetcar on Grand Ave. If there is a street car approaching on Grand, the Non-Revenue street car will wait to make a call until the revenue street car passes. Once the street car passes the streetcar operator will then initiate an S2 route request by using the TWC carborne unit to dial in the train ID number and correct route number. The carborne unit will then transmit the message to the TWC wayside interrogator unit located in signal case RC1, which will in turn transmit the message serially to the streetcar signaling microprocessor. The microprocessor will then transmit a preemption request to the traffic signal control system.
 - 3) The preemption request will then activate a sequence that will place the 3rd Street traffic signal to stop for all directions for vehicular traffic. Once this has been accomplished the traffic signal control system will then transmit an indication to the streetcar signaling microprocessor indicating that it is now safe to clear the S2 signal for a straight-through route exiting at signal S6. Once the proper aspect is displayed, the streetcar operator will then accept the signal and proceed over track 1T and Switch 1 (trailing point move) and will position the vehicle over TWC loop L6, which is located adjacent to signal S6.
 - 4) Once the streetcar is properly positioned over the L6 TWC loop the operator will key down the south end of the vehicle and will then proceed to the opposite end of the vehicle and key up the north end. The operator will then initiate a route request for a move from S6 to the 3rd St. station on the revenue southbound track. This will initiate a preemption sequence that will place the Grand Boulevard/3rd Street traffic signal to stop in all four directions. Once the signaling microprocessor receives the indication that it is safe to clear signal S6, the streetcar will be routed over Switch 1 onto the Southbound Track, exiting at bar signal S4. The operator will then accept the signal and will position the vehicle into the 3rd St. Station and begin revenue service.
 - b. Returning to Vehicle Maintenance Facility
 - 1) A streetcar exiting the mainline heading towards the shop on the Northbound Track will position itself over the L6 TWC loop. The vehicle operator will then initiate an S6-to-S2 route request. This will initiate a preemption sequence that will place the Grand Boulevard/3rd Street traffic signal to stop in all four directions. Once the signaling microprocessor receives the indication that it is safe to clear signal S6, the operator will proceed onto the non-revenue tracks and head towards the shop area once the signaling system safely clears the signal and properly positions Switch 1 for the requested move.

- 2) Streetcar traffic entering and leaving the non-revenue tracks will need to be coordinated by dispatch to effectively control the flow of vehicles from the vehicle maintenance facility into revenue service and vice versa.
- c. Union Station
- 1) Once the operator has closed the doors the operator will pull forward over the TWC loop L8, which will initiate a signal to the traffic controller to turn the traffic signals to red at the Union Station pedestrian bridge. Once the traffic signals are set to red, the traffic controller will illuminate a proceed indication via the bar signal S8, mounted on the traffic pole. Once the bar signal indicates proceed, the street car will proceed across the IJ in front of the points of switch which will drop the track occupancy track circuit. The track occupancy track circuit will latch the traffic signals red until the street car completes the diverging move on to the North Bound track. During this phase the pedestrian cross walk indicators shall prohibit pedestrians from crossing in the crosswalk. Once the street car clears the North Bound IJ, the occupancy track circuit relay will pickup and send a signal to the traffic control to change the traffic signal to green.
- d. Future possibility – will provide infrastructure.
- 1) Once the streetcar is properly positioned over the L4 TWC loop the operator will key down the west end of the vehicle and will then proceed to the opposite end of the vehicle and key up the east end. The operator will then initiate a route request for a move from S4 to S6 that will initiate a preemption sequence that will place the Grand Boulevard/West 3rd Street traffic signal to stop in all four directions including the traffic signal at 5th and Grand. Once the signaling microprocessor receives the indication that it is safe to clear signal S4, a request will be initiated that will route the streetcar over Switch 1 onto the Northbound Track (heading south), exiting at bar signal S6. The operator will then accept the signal and will proceed onto the North Bound mainline for a move back into the shop using TWC L6 and signal S6 as described above.
2. Train to Wayside Communications (TWC) systems to:
- a. Automatically call routes through interlockings
 - b. Call individual switches at interlockings
3. Interlockings
- a. The following requirements shall apply to all interlockings:
 - 1) Detector, approach, indication and route locking shall be provided at each interlocking.
 - 2) Detector locking at interlockings shall not be released until 5 seconds after the slow pick-up track repeater relays have closed their front contacts.
 - 3) All non-interfering movements shall be permitted simultaneously.
 - 4) The control of all interlockings and non-interlocked locations shall be microprocessor based.
 - 5) Circuit design shall conform to the American Railway Signaling Principles and Practices of the AREMA (AAR) Communications and Signals Manual, including, but not limited to, Part 16, Vital Circuit and Software Design.

- 6) Approach locking and time locking shall be released by a single track circuit indicating occupancy of the previously established route. This release shall be accomplished through the use of relay contacts of the first repeater relay of the appropriate track relay.
 - 7) Approach locking and time locking shall be effective for all interlocking signals in the event of a momentary loss and subsequent restoration of AC and/or DC signal power. This means that Approach Stick Relay's (ASR's) shall not be restored upon a momentary loss and restoration of power and that ASR circuits shall incorporate the use of a Power Off Stick Relay (POSR) type arrangement.
4. AC power supply system capable of powering all signal equipment used on the Project

1.6 STANDARDS AND CODES

- A. The Street Car Signal System shall be designed, constructed and tested to the latest revision at the time of award of the Contract to the following codes and standards:
1. U.S. Code of Federal Regulations (CFR 49 Part 236 and Part 234).
 2. American Railway Engineering and Maintenance-of-Way Association (AREMA, formerly AAR)
 - a. Communications and Signals Manual
 3. National Electrical Code (NEC)
 4. National Electrical Safety Code (NESC)
 5. Insulated Cable Engineers Association (ICEA)
 6. Institute of Electrical and Electronic Engineers (IEEE)
 7. National Fire Protection Association (NFPA)
 8. Underwriters Laboratories Inc. (UL)
 9. U.S. Department of Transportation, Federal Highway Administration "Manual on Uniform Traffic Control Devices"
 10. American Society for Testing and Materials (ASTM)
 11. American National Standards Institutes, Inc. (ANSI)
 12. Rules and Regulations of the Colorado Public Utilities Commission (PUC)

1.7 SERVICE PROVEN EQUIPMENT AND DESIGN

- A. The Contractor shall furnish signal equipment proven in similar railroad or rail transit service and shall make use of this experience to prepare a suitable and proven design for this application. Each component, subassembly and assembly furnished by the Contractor shall be of a proven design with a history of at least 10 years of successful revenue service operation on at least three different railroad or transit properties in North America.
- B. Vital relays, vital microprocessor interlocking equipment, switch machines, switch locks, switch circuit controllers, and signals shall have a history of at least 10 years of successful revenue service on each of at least three different railroad or rail transit properties in North America.

- C. Wire, cable and the wire and cable manufacturer shall have proven service histories as required by SECTION 34 42 16 – Wire And Cable.
- D. The Signal System shall have an expected service life of 40 years at the specified level of service. Achievement of this useful life shall be through the use of off-the-shelf proven hardware. Each major component, subassembly and assembly shall incorporate provisions to allow for the functional and physical interchangeability of replacement spare parts.
- E. The Contractor shall be fully responsible for designing, furnishing, installing and testing a safe and reliable Signal System, independent of any other requirement of this Specification.

1.8 DESIGN CRITERIA

- A. Failsafe Design
 - 1. The Contractor shall base the design of the Signal System on their System Safety and Security Certification Plan.
- B. The Agency Design Criteria shall be considered to be a part of this Specification.
- C. Modular Design
 - 1. The Contractor shall use modular design throughout.
 - 2. The Contractor shall organize electrical and mechanical components in rack-mounted, plug-in assemblies.
 - 3. The Contractor shall minimize the mixing of equipment associated with two subsystems into one plug-in assembly.
 - 4. Equipment serving similar functions shall be in the same relative location in all cases where practical.
 - 5. Printed circuit cards designed to perform the same function shall be interchangeable regardless of whether these cards are of the same or different subsystems.
 - 6. All printed circuit cards used for signal equipment shall be mechanically or electrically keyed to prevent improper insertion, damage or operation.
 - 7. Equipment Arrangement
 - a. All equipment and components shall be accessible for testing or replacement without removal of other components.
 - b. Two or more points of adjustment which are required during the same operation shall be located in such a way that they can be operated by one person.
 - 8. Wiring
 - a. All incoming cables shall be terminated on standard AAR terminals with concave test link nuts. These nuts, when backed off, will open the circuits without removing the wires from the terminal posts. A maximum of two wires shall be permitted on each AAR terminal. All spare conductors in all cables shall also be tagged and terminated on AAR terminals with test links.

- b. Main power feeders shall have segregated facilities for entering and leaving each relay case. Power feeders shall be terminated on the power rack, sideboards or shelves.
 - c. The Contractor shall provide insulated nuts and protective covers for personnel safety on all exposed terminations above 50V and shall meet the requirements of the AREMA Communications and Signals Manual, Part 11.1.1 (Recommended Functional/Operating Guidelines for Electrical Safety), except as otherwise specified herein, or as Approved by the Agency.
 - d. Wires distributing AC and DC power within each and case shall originate from the power buss and terminate on the power distribution terminals. These wires shall be a minimum of #10-gauge and sized to limit line loss to less than 5%.
 - e. Except for main power feeders, all wiring entering or leaving each relay case shall be connected with crimp connectors to AAR terminals located on the entrance rack.
 - f. Entrance rack terminations shall be constructed and arranged to permit case wiring to be isolated from the field wiring, on an individual wire basis, without removing wires from their terminals. This shall be accomplished by use of standard AAR terminals and concave test link nuts as specified above, or as Approved by the Agency.
 - g. All wiring shall be supported at intervals that maintain an orderly installation and provide strain relief, particularly near terminal points.
 - h. The mechanical strength of each connection shall be at least 85% of the mechanical strength of the wire. Electrical conductivity of each connection shall be at least 95% of the electrical conductivity of the wire.
 - i. A minimum of 10% spare terminals (but no less than two terminals) shall be provided on each terminal block. Terminals used for the termination of spare wires shall be considered spare terminals. Exceptions to this requirement shall be Approved by the Project Manager.
 - j. Where card cages, switch modules, or switch matrices are installed, all connections on the back plane or switch base shall be wired to the main frame regardless of whether cards are to be installed or switch or light functions are to be used in the initial system functions. Any panel connections shall be plug or connector ended to facilitate removal for maintenance.
 - k. All wires connecting to relay plug boards and sockets shall be crimped. No terminations requiring soldering shall be used.
9. Test Points
- a. Test points for checking essential voltages and waveforms and for injecting test signals shall be provided where required for troubleshooting and routine maintenance except where vital function of the circuit is compromised.
 - b. Selected test points shall be provided to detect defective printed circuit cards and equipment modules without disconnection of wires except where vital function of the circuit is compromised.
 - c. All test points shall be accessible without removing any components.

- d. Digital electronic equipment may use status or fault indicators in lieu of test points.
- D. Adjustments
1. Adjustable components shall be avoided wherever possible by use of appropriate circuitry, stable components, and high-tolerance circuits.
 2. Adjustable components not intended for adjustment by operating personnel shall have locking devices or shall be self-locking to prevent inadvertent operation or drift. Special precautions, including limitation of adjustment range, shall be established for vital calibrations.
 3. Interacting adjustments shall be avoided.
 4. Where possible, replacement of components or printed circuit cards with spares shall not require compensating adjustments to other components or modules.
 5. When built-in indicators or meters are associated with adjustments, the adjustment point shall be sufficiently close to the associated indicator so both may be manipulated and observed by one person.
 6. No combination of misadjustments shall result in equipment damage or an unsafe condition.
- E. Environmental Parameters
1. Except as otherwise specifically provided for in other Sections, all systems and equipment shall perform properly without damage under the following conditions, and shall meet the requirements of the AREMA Communications and Signals Manual, Part 11.5.1 (Recommended Environmental Requirements for Electrical and Electronic Railroad Signal System Equipment), except as otherwise specified herein, or as Approved by the Agency.
 - a. All equipment shall be designed to operate from a minimum temperature of -40 degrees Celsius (ambient) to a maximum temperature resulting from a combination of ambient temperature, maximum sun loading and maximum normal internal heat generation of +70 degrees Celsius.
 - b. Relative humidity range shall be 5% to 95% non-condensing.
- F. EMI-Related Design Requirements
1. The Signal System shall be designed to operate in the electromagnetic environment present in the general area of the Street Car while causing the minimum possible interference to other systems. The equipment shall be designed, selected and installed with consideration given to the electromagnetic environment, which includes but is not limited to traction power supply, AC power distribution systems, vehicle propulsion systems, communications systems, adjacent railroads and electric utility lines.

PART 2 - PRODUCTS

2.1 PRINTED CIRCUIT CARDS

- A. Printed circuit (PC) cards shall be as specified in SECTION 34 42 29 – Signals Electrical And Electronic Components for housing in 19-inch card files.

- B. Card-mounted components weighing more than 1/2 ounce or with a volume of more than 1/2 cubic-inch shall have a structural attachment to the card separate from the electrical attachment.
- C. When practical, wires serving the same function shall be connected to the same terminal of PC cards used in the same subsystem, and cards containing the same circuitry shall be interchangeable between subsystems.
- D. PC cards shall be wired so that removal does not create an unsafe condition.
- E. All PC cards shall have mechanical or electrical keying that will prevent improper insertion, damage or interchange.

2.2 ELECTRONIC CIRCUITS

- A. All electronic equipment used on this Contract shall be semiconductor type, except as otherwise specified.

PART 3 - EXECUTION

3.1 TRAIN SAFETY

- A. Train safety shall be the primary consideration in the design of the Signal System and in the selection of its components including relays and other devices with moving parts, insulated wire, wire terminals, terminal posts, fuses, circuit breakers, housings, junction boxes, conduits, power supplies, resistors, capacitors, transformers, inductors and other similar items. The entire Signal System shall meet the requirements of this Section.
- B. In this Section the terms "restrictive" and "permissive" are used in connection with the binary outputs of two-position components or subsystems and denote such alternatives as:
 - 1. Stop and proceed
 - 2. A lower speed and a higher speed
 - 3. Deceleration and acceleration
 - 4. Brakes applied and brakes released
 - 5. Actuation of alarm and no actuation of alarm
- C. The following requirements shall govern the design of the portions of the system or a subsystem, which affect train safety:
 - 1. Only components that have high reliability and predictable failure modes and have been proven in conditions similar to the projected service shall be utilized.
 - 2. Components shall be combined in a manner that ensures a restrictive rather than a permissive condition will result from a component failure.
 - 3. All circuits which are not confined to one housing and which affect safety shall be two wire, double-break, except signal and switch indicator lighting circuits.
 - 4. The design shall be based on closed circuit principles. Broken wires, dirty or high-resistance contacts, a relay failing to respond when energized, a loss of power supply energy, or any combination of these failures, shall not result in unsafe conditions.
 - 5. Component or system failures shall cause a more restrictive signal indication than that permitted with no failure.

6. System safety apparatus design shall be such that any single independent component or subsystem failure shall result in a safe condition. Failures that are not independent (those failures which in turn always cause others) shall be considered in combination as a single failure and shall not cause an unsafe condition.
7. Electronic circuit design shall ensure that the following types of component failures have a restrictive rather than a permissive effect:
 - a. Two terminal devices – open, short, partial open, or partial short
 - b. Multi-terminal devices – combination of opens, shorts, partial opens, and/or partial shorts
8. Wherever possible, built-in checks shall be included that impose a restriction and/or actuate an alarm whenever a device fails to assume its most restrictive position when conditions require that it should.
9. Redundancy shall not be considered an acceptable method of achieving design safety.
10. Circuits and grounds shall be wired so that equipment removal does not create a hazard.
11. Non-vital contacts shall not be intermixed with vital contacts in safety circuits except when non-vital contacts are located at the head (farthest from the relay coil) end of the positive and/or negative feeds to relay coils.
12. Equipment containing circuitry-affecting safety shall be designed to include mechanical and/or electrical keying to prevent improper insertion or interchange.
13. The normal position of switches shall be as shown on the Contract Drawings.
14. The supplied equipment shall function properly in an environment where the temperature may vary from -40 degrees Celsius to +70 degrees Celsius.
15. Any latent failure of the equipment, that is a failure, which by itself does not result in an unsafe condition, but which in combination with a second or subsequent failures could result in an unsafe condition, must be detected and negated within a stipulated time period.

3.2 SUBMITTALS

- A. Drawings, documents and software to be submitted by the Contractor to the Project Manager shall include, but not be limited to, those listed below. All submittals required by this Section shall be submitted to the Project Manager in accordance with SECTION 01 33 00 – Submittal Procedures. The Project Manager reserves the right to request additional drawings or documents as required, to clarify and amplify the intent of the items previously submitted. Agency approval of any submittal shall in no way relieve the Contractor from the responsibility to provide a safe system that meets all of the requirements of this Specification.
 1. Document, Drawing and Software Submittal List – A document, drawing and software submittal list shall be prepared by the Contractor and submitted to the Project Manager. This list shall contain all documents, drawings and software to be submitted and an estimated schedule for initial release through final or as-built versions for each document, drawing or piece of application software.

2. Drawing Index – An updated drawing showing each drawing's title, drawing number, sheet number and revision information shall be provided with each drawing submittal.
3. Symbols Listing – An updated drawing showing each circuit symbol and track symbol used on the circuit plans and other Contract Drawings, along with the meaning of each symbol, shall be provided with each drawing submittal.
4. A complete systemwide track and cable plan shall be submitted showing the location of all station platforms, track switches, switch machines, switch locks, switch circuit controllers, switch heaters, track circuit feed points, track circuit relay points, signals, TWC loops, signal cases, and interconnecting cables. This plan shall be to scale and show survey stationing. This plan shall be submitted to the Project Manager prior to the preparation of any circuit plans or software, and prior to ordering of any cable or other material.
5. Prior to the preparation of any final circuit plans, the Contractor shall submit to the Project Manager for Approval, a typical set of circuit plans for a typical interlocking. The Project Manager will review these sets of typical circuit plans for consistency with their current practices in terms of circuit nomenclature, drawing and circuit presentation, and circuit design principles and practices. The Contractor shall schedule and hold design review meetings at which time the principles depicted in the typical circuit plans shall be discussed and brought into compliance with the Agency design standards.
6. Prior to the preparation of any final application software the Contractor shall submit a sample program to the Project Manager for Approval for a typical interlocking. The Project Manager will review these programs in order to set up a standard format for all application programs. The intent is that all application programs have the same general format. The Contractor shall schedule and hold design review meetings at which time the principles depicted in the typical application programs shall be discussed and brought into compliance with the Agency design standards.
7. Apparatus Tabulations – A drawing containing an updated listing of each component used in the system shall be submitted with each drawing submittal. The apparatus tabulation shall contain each component's:
 - a. Reference number
 - b. Name
 - c. Contact configuration
 - d. Description
 - e. Manufacturer's name, address and component order number
 - f. Base or plug coupler manufacturer and component order number
 - g. Functional use or purpose in the system

8. Circuit Plans – Complete systemwide circuit plans shall be prepared by the Contractor and submitted to the Project Manager showing all signals, switch machines, switch locks, switch circuit controllers, switch heaters, termination points, relay coils and contacts, controls, signal equipment and energy busses with all interconnections. Spare contacts and contact usage shall be shown on a separate page of the circuit plans. Circuit plans shall be submitted to the Project Manager prior to any installation work or factory wiring of cases. These plans, combined with the application software, shall be the controlling documents of the design and shall be under the control of one design entity within the Contractor's organization. It shall be Contractor's responsibility to determine by means of a re-check of the completed system circuit plans and application software that these plans provide the safety and operation required by the Contract. The Contractor shall further be required to modify these plans and programs as required due to design changes such that the Agency receives a completely accurate set of plans when the job is complete.
9. Application Programs – Application programs shall be submitted to the Project Manager prior to any installation work or factory wiring of cases.
10. Software Document Control Procedure – The Contractor shall design and implement an application software control procedure. This procedure shall be designed to ensure that from the time the factory testing is complete through the time in-service testing is complete (cutover) strict control of the version of application software for each location is maintained. This control procedure shall be submitted to the Project Manager for Approval. This procedure shall be approved and in force prior to any locations being shipped to the Project. Violation of the provisions of the software control procedures shall be, at the discretion of the Project Manager, grounds to require complete re-testing of all affected locations.
11. Relay Equivalent Circuits – All application software shall be converted, by an automatic process, into relay equivalent circuits. The intent is that the application logic will be depicted using standard relay symbols such that an experienced signal person with no knowledge of ladder logic or Boolean algebra will be able to interpret the programs. A sample of the equivalent circuits shall be submitted to the Project Manager prior to writing any application programs. The relay equivalent circuits shall be included in the book of plans for each location.
12. Physical Layout Drawings – Drawings showing the physical arrangement of all wayside equipment including, but not limited to signals and cases. Also submit layouts for equipment within the relay case. In addition, physical layout drawings of all signals, local control panels, and track switches shall be submitted, prior to the manufacture of any of these items. These drawings shall be drawn to scale and contain a parts list of all items to be furnished by the Contractor. The Contractor may incorporate this information as a part of the circuit plans for each case. These drawings shall be submitted to the Project Manager for Approval.
13. Installation Drawings – Installation drawings shall be prepared for each major piece of signal equipment to be installed such as junction boxes, signals, relay racks, and signal cases, etc. These drawings shall be to scale and contain a parts listing. These drawings shall be submitted to the Project Manager prior to the start of any field installation work.
14. Test Program Plan – A test program plan shall be submitted to and Approved by the Project Manager as required by SECTION 34 42 76 – Signals Tests and Inspections.

15. Test Reports – A test report, for each test conducted pursuant to this Contract, shall be submitted to and Approved by the Project Manager prior to tendering the system for Street Car Completion. Each test report shall include a copy of the Project Manager Approved test procedure, copies of all test data sheets and shall bear the signature of the Contractor's Engineer/Inspector conducting the test.

3.3 PERCENTAGE SUBMITTALS

- A. Some of the submittals, as detailed below, shall be made on a percentage basis. The intent of this is to secure an early review of basic design concepts to avoid rework and schedule delays. The items to be included in each submittal at each percentage level are intended to be a guideline only. At all levels, the more details relating to the design that the Contractor can submit, the better.
 1. Application Software
 - a. 50% level – The basic elements to be reviewed at this level are the basic design concepts. At this level the program shall have enough details so that it is possible to determine how the signal system will operate. Elements to be reviewed include:
 - 1) Signal Control
 - 2) Switch Control
 - 3) Vital Logic
 - 4) Non-Vital Logic
 2. 90% level – At this level the program shall be essentially complete and ready for factory testing. The only items that are yet to be determined are “last minute” things such as timer settings, etc.
 3. Circuit Plans
 - a. 50% level – The basic element to be reviewed at this level is the operation of the location for which the circuits being reviewed have been prepared. The circuits, both vital and non-vital, shall have sufficient detail so that it is possible to determine all the details of how the associated location will function when it is placed in service. All hardware items to be used in the final design shall appear on the circuit plans at this level.
 - b. 90% level – At this level the location is essentially ready to be sent to the factory for wiring. All details relating to pin assignments, contact fanning, rack position, cable numbers, fuse and wire sizes, terminal numbers, etc. shall be included in the circuit plans to be reviewed.
 4. Physical Layout of Relay Cases
 - a. 90% level – At this level the case is essentially ready for manufacture. Elements to be reviewed at this level include but are not limited to:
 - 1) Details of the case layout. This includes where each piece of equipment is located in the rack, details of mounting, etc.
 - 2) Organization and layout of the entrance rack
 - 3) Details relating to the Local Control Panel
 - 4) Grounding details

- 5) Layouts of all terminal boards and power distribution
- 6) Power buss organization

3.4 SIGNAL EQUIPMENT REQUIRING APPROVAL

A. Signal equipment to be submitted by the Contractor to the Project Manager shall include, but not be limited to, the items listed below. For each item listed below, the Contractor shall submit a catalog-cut sheet and equipment service manual. The Project Manager reserves the right to request additional drawings or documents as required, to clarify and amplify the intent of the information submitted.

1. Batteries
2. Battery chargers
3. Circuit Breakers
4. Conduit
5. Exothermic welding kits
6. Fuses
7. Power Transfer switches
8. Junction boxes
9. Lightning arrestors
10. Local control panels
11. Non-vital relays
12. Padlocks
13. Power frequency track circuits
14. Power supplies
15. Signal cases
16. Signal case foundations
17. Signals
18. Spare parts
19. Special tools
20. Switch circuit controllers
21. Switch Heaters
22. Switch machines
23. Tags for wire, cable, rack, equipment, etc
24. Terminals and terminal strips
25. Transformers

26. TWC Interrogators
27. Vital and non-vital processors
28. Vital and non-vital relays
29. Wire and Cable

3.5 DRAWINGS AND DETAIL DESIGN EVALUATION DATA

- A. In support of the detail design reviews, provide five full-size prints of sufficient quality to make legible prints of those engineering drawings and documents that provide all essential data necessary to permit a meaningful evaluation and feasibility study of the proposed detail design. All drawings shall be dimensioned in English units. All text shall be in the English language.
- B. In addition to the other drawing requirements specified in these Specifications, five full-size prints of sufficient quality to make legible prints of the following shall be submitted for the Agency's Approval :
 1. Installation drawings for each type of field equipment.
 2. Outline drawings of all major equipment components showing:
 - a. Overall dimensions, orientation, points of normal support and method of mounting and removal
 - b. Location of access doors and covers showing the relation to equipment inside the enclosure
 - c. Required draw-out space and space for opening of access doors
 - d. This information may be included as a part of the physical layout of the relay cases.
- C. Manufacturing Drawings
 1. Throughout the engineering and manufacturing process, submit a continually updated list of manufacturing interconnect and assembly drawings and engineering change orders. Detail drawings shall be submitted at the Agency's request. Within 15 calendar days of their release or revision, five full-size prints of sufficient quality to make legible prints of manufacturing drawings shall be submitted to the Agency.
 2. Prior to completion of the Contract, the Contractor shall submit to the Agency a complete set of final (as-built) manufacturing drawings with all changes incorporated thereon. Two reproducible and five copies of the above drawings shall be submitted.
- D. Drawing Quality and Updating
 1. Drawings shall be of a quality where every line, number, letter and symbol is clearly legible. Reproducible drawings shall be capable of reproducing drawings to this quality level. The Contractor shall update each drawing, incorporating all outstanding approved changes, at least once every 60 days. In no event shall more than five approved changes be accumulated against a drawing without incorporation, irrespective of its scheduled update. Changes to drawings shall be incorporated sequentially. Copies of all updated drawings which were submitted to the Agency in an earlier revision shall be resubmitted in the original quantity and format.

- E. Calculations
 - 1. Furnish calculations and other required data on standard 8-1/2 by 11 inch sheets, printed on one side only. Each sheet shall bear the following: contract name and number; title and number of pages; data and revision status. The calculations shall include those for power, racks, relays, wire sizes and voltage drops, and all other required calculations.
- F. Drawing Approvals
 - 1. If Approved by the Project Manager, a reproducible copy of each drawing will be identified as having received such Approval by being so stamped and dated. Drawings stamped "not Approved" or "Approved subject to" and with required corrections shown will be returned to the Contractor for correction and resubmittal. Resubmittals will be handled in the same manner as first submittals.

3.6 CONFIGURATION MANAGEMENT PROGRAM

- A. Maintain and make available to the Agency accurate and current configuration records throughout the performance of the Contract and for a 3-year period after final Contract payment.
- B. Do not procure nor produce any hardware or software until such items have been Approved by the Agency.
- C. All items, beginning with the lowest level of repair or replacement, identified by the same part number shall have the same physical and functional characteristics, be equivalent in performance and durability, and be interchangeable without alteration to themselves or associated items, other than normal field adjustments. An item shall not be considered interchangeable if it requires modification for fit or performance. Old and new configuration items that require segregation shall be identified either by a new drawing number or a dash number added to the original drawing.
- D. Hardware Identification
 - 1. Mark all hardware components to the lowest level of repair and replacement with part number identification. The hardware identification marking shall coincide with the officially released engineering data. Nameplates on major equipment items will provide space for the Agency numbers to be added by the Contractor at the direction of the Agency. Serialization is required on each item of equipment delivered unless otherwise directed by the Agency. Assign an individual serial number in a numerical sequence established for the type or model series equipment being supplied. Do not use duplicate serial numbers within a type or model series. Serial numbers shall not exceed ten digits in length.
- E. Accountability
 - 1. Maintain records such that the configuration of any items being delivered shall be definable in terms of its component part numbers. Account for differences between the as-built configuration and the engineering released documentation. Record status of change approvals and incorporation at each point in product development, test, production or operational usage. Maintain a serialization and configuration record. Maintain the status of interface specifications, control documents and plans. Maintain status of software once a baseline has been defined.

3.7 AS-BUILT DRAWINGS, SOFTWARE, AND DOCUMENTATION

- A. As-Built or Final Design Documents shall be submitted to and Approved by the Project Manager prior to tendering the system to the Project Manager for Street Car Completion. These drawings and documents shall include the latest revision of all previously submitted drawings and documents and shall show the final system configuration as tendered for Street Car Completion. All of the final drawings and documents submitted to the Project Manager shall bear the seal of a Professional Engineer (P.E.) registered in the State of Missouri. All cable plans, apparatus tabulations, drawings, indexes, circuit plans, trenching plans, and case layout drawings, installation plans, TWC interrogator plans, equipment layout drawings, equipment schematic diagrams, block diagrams and all other drawings produced specifically for the Project shall be submitted per the Agency's latest revision of General Drafting and Design Standards for AutoCAD and Microstation.
1. The as-built drawings shall include a document and drawing list. This list shall contain all documents and drawings submitted.
- B. As-built or final application software shall be submitted to the Project Manager prior to tendering the system for Street Car Completion. This final application logic shall include all of the changes previously made and tested. The application logic shall also include final as-built versions of the relay equivalent circuits. The application logic shall be submitted in the following format.
1. The application logic and associated relay equivalent circuits for each wayside location shall be printed out on standard 8 1/2-inch by 11-inch paper. These printouts shall be placed in a standard three ring binder of the appropriate size. Each binder shall be labeled according to the location contained in the binder. These binders shall be placed in each relay case along with the required location circuit plans and route and aspect plans.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

- A. The quantities of accepted work will be measured in the following units. All measurements will be plan measure except for authorized changes.
1. Description: Lump Sum

4.2 PAYMENT

- A. Payment will be made at the respective unit or lump-sum price listed in the proposal and shall be full compensation for all labor, materials, and equipment necessary to complete the respective unit in place. There will be no separate measurement or payment for any item of work not specifically identified and listed in the proposal, and all such work shall be considered a subsidiary item with all costs pertaining thereto included in the prices for other items listed in the proposal. At the Engineer's option, partial payment may be made for any lump sum item listed in the proposal, providing that the Contractor is diligently and satisfactorily pursuing full completion of such partially complete item in accordance with the approved job progress schedule.

END OF SECTION

SECTION 34 42 11**SIGNALS GENERAL INSTALLATION REQUIREMENTS****PART 1 - GENERAL****1.1 SUMMARY**

- A. This Section details the general requirements and responsibilities the Contractor shall adhere to when installing the various pieces of signal equipment.

1.2 RELATED SECTIONS

- A. SECTION 01 43 00 – Systems Quality Assurance
- B. SECTION 26 05 33.13 – Systemwide Electrical Raceways for Systems
- C. SECTION 26 05 43 – Systemwide Electrical Underground Ductbanks for Systems
- D. SECTION 34 42 16 – Signals Wire and Cable
- E. SECTION 34 42 33 – Signals Prefabricated Relay Cases
- F. SECTION 34 42 44 – Signals Power Distribution

1.3 SUBMITTALS

Not Used

1.4 QUALITY ASSURANCE

- A. The Contractor shall comply with the requirements of Division 1.

PART 2 - PRODUCTS

Not Used

PART 3 - EXECUTION**3.1 GENERAL**

- A. The Contractor shall provide an extension of incoming power services at all relay cases as specified in SECTION 34 42 44 – Signals Power Distribution.
- B. The Contractor shall provide the grounding system as specified in SECTION 34 42 33 – Signals Prefabricated Relay Cases and SECTION 34 42 44 – Signals Power Distribution.
- C. The Contractor shall cover all holes, trenches and excavations when they are not attended. Dimension lumber, planking and plywood shall be employed. Tape or other barrier shall not be acceptable for protection.
- D. The Contractor shall maintain clean ballast at all times. The Contractor shall correct all ballast contamination due to his work as part of this Contract.
- E. The material used for Thermite exothermic welding shall consist of a copper mixture and shall cause the rail joint bond connection to be fused to the rail in a solid homogenous mass. The resistance of 24 inches of conductor containing a welding connection shall not exceed the resistance of 30 inches of plain conductor.

F. General Bonding Requirements

1. The Contractor shall furnish and install two "C" type power bonds, as specified in SECTION 34 42 16 – Signals Wire And Cable, across all non-insulated rail joints on rails carrying traction power negative return current. The rail joint bonds shall be Thermite exothermically welded to the non-gauge side of the railhead within the limits of the rail joint bar.
2. The Contractor shall furnish and install two 250 MCM cables, as specified in SECTION 34 42 16 – Signals Wire And Cable where required for negative return rail transpositions. The cables shall be Thermite exothermically welded to the neutral axis of the rail.
3. The Contractor shall furnish and install all signal and power bonds necessary to meet the functional requirements of the Contract. This shall include but not be limited to traction power bonds, special track work bonding, etc.
4. All exposed cable and exothermic bonds shall be coated with an anti-oxidation coating. All bonding wires or cable not installed in conduit, other than the "C" type, shall be secured to the ties. All wire and cable installed between the rails shall be routed and secured in a manner that provides the maximum protection from dragging equipment and track maintenance equipment.

G. Signal Rail Bonds

1. Track circuit connections to the rail for power frequency track circuits shall be made with a piece of bond strand wire as specified in SECTION 34 42 16 – Signals Wire And Cable, which is manufactured for this specific application. The bond strand shall be cut to length and Thermite exothermically welded to the neutral axis of the rail. The bond strand between the stub-up and the rails shall be of sufficient length to permit a short service loop to be included in the run.
2. Signal rail transpositions, where required for power frequency track circuits, shall be made with two lengths of bond strand wire as specified, and Thermite exothermically welded to the neutral axis of the rail.
3. Negative return rail transpositions, where required for single rail power frequency track circuits, shall be made with two lengths of 250 MCM cable and Thermite exothermically welded to the neutral axis of the rail.

H. The Contractor shall ground junction boxes, relay cases and signal heads. Track switch machines shall be isolated from ground.

I. Unless otherwise specified, all hangers, brackets, clamps, bolts, nuts or washers shall be hot-dip galvanized. The zinc coating shall be of commercially pure zinc and shall be continuous and thorough with at least 2 ounces of zinc per square foot of galvanized surface. The plating shall not scale, blister or be removable by any process of handling during installation. All material shall be cut, formed or drilled prior to plating. All lock washers, bolts, nuts and washers used within enclosures shall be cadmium plated. The cadmium plating shall be an impervious, dense, hard, fine-grained, continuous, closely adhering coating of commercially pure cadmium. The plating shall completely cover the surface of the part with a minimum thickness of 0.0006 inches in a smooth, bright layer.

J. The Contractor shall not mount equipment on a station platform unless Approved by the Project Manager.

K. The Contractor shall perform all painting prior to installation. Any painted areas damaged during shipment or installation shall be repainted with matching colors.

- L. Where the emergency guardrail interferes with the installation of wayside signal equipment, the Contractor shall cut or notch the guardrail in a manner Approved by the Project Manager.
- M. The Contractor shall use pre-cast concrete bases or pedestals wherever signal equipment foundations are required.
- N. The Contractor shall excavate for the installation of signal and relay case foundations. When excavating, the Contractor shall
 - 1. Use a protective covering over track ballast to prevent contamination during excavation and backfill operations. Remove contaminated ballast and restore the ballast to original condition including tamping, sweeping, etc.
 - 2. Excavate to a depth of between 18 and 36 inches as directed by the Project Manager. Prior to the installation of a foundation, place a 6-inch minimum layer of 1 1/2 inch maximum washed gravel in the bottom of the hole and thoroughly tamp.
 - 3. Remove soft or unsuitable material existing below the required subgrade and replace with compacted gravel. Remove rock or boulders below the subgrade to a minimum depth of 1 foot below the bottom of the foundation.
- O. The Contractor shall provide service loops in all wire terminations.
- P. Signal Installation – The Contractor shall install all signals in accordance with
 - 1. Detailed signal equipment manufacturing/layout drawings submitted to the Project Manager.
 - 2. Detailed signal installation drawings prepared by the Contractor and submitted to the Project Manager for Approval. These drawings need not duplicate information previously submitted to the Project Manager as signal manufacturing/layout drawings. These installation drawings shall be to scale, show major dimensions, and contain a parts list with catalog references. These drawings shall include installation methods and procedures for all wayside signals.
 - 3. Signals shall be located in relation to insulated joints, track circuit boundaries, TWC loops, etc. as shown on the Contract Drawings.
 - 4. All openings in signal light units shall be suitably plugged or capped for protection during shipment.
- Q. Signal Mounting Arrangements and Foundations
 - 1. Wayside signals shall be mounted on the nearest appropriate OCS pole, traffic pole or individual signal pole.
 - 2. Each color light signal shall generally be on the right hand side of the tracks when viewed by a train traveling in the normal direction depending on streetscape and vehicular traffic. The locations of the signals are shown on the Contract Drawings.
 - 3. The Contractor shall manufacture and install all signal assemblies so that all parts clear the light rail car Dynamic Outline by 6 inches or more, as shown on the Contract Drawings
- R. Wiring
 - 1. Wires and cables to all signals shall be terminated on terminal blocks in accordance with AREMA (AAR) Communications and Signals Manual Part 14.1.8 (Recommended Design Criteria for Molded Terminal Block, Details & Assemblies).

2. Wires and cables to color light signals be run through underground conduit ductbanks, conforming to SECTION 26 05 43 – Systemwide Electrical Underground Ductbanks For Systems and SECTION 34 42 16 – Signals Wire And Cable, to AREMA (AAR) terminals in the junction box bases of each signal.
3. Cables inside manholes shall run on racks. Racks shall be fiberglass or have porcelain or fiberglass cable-support insulators made for that purpose. Metal parts shall be bonded to the manhole ground rod.
4. Supporting racks shall have a maximum spacing of 3 feet and shall be installed to avoid excessive weight or pressures on the cable insulation. Racks shall also prevent cable damage from short circuit forces. Cables shall be arranged in not more than two layers and secured with cable ties or straps

S. Painting

1. All paint and painting procedures shall be in accordance with applicable requirements given in the AREMA Communications and Signals Manual Part 1.5.10 (Recommended Instructions for Painting and Protective Coatings), except as otherwise specified, or as Approved by the Agency.
2. The Contractor shall prime and paint the inside and outside of all signal equipment installed, as required, to touch-up any nicks, scratches, dents, and other surface defects caused during manufacturing, shipping, installation or testing.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

- A. The quantities of accepted work will be measured in the following units. All measurements will be plan measure except for authorized changes.
 1. Description: Lump Sum

4.2 PAYMENT

- A. Payment will be made at the respective unit or lump-sum price listed in the proposal and shall be full compensation for all labor, materials, and equipment necessary to complete the respective unit in place. There will be no separate measurement or payment for any item of work not specifically identified and listed in the proposal, and all such work shall be considered a subsidiary item with all costs pertaining thereto included in the prices for other items listed in the proposal. At the Engineer's option, partial payment may be made for any lump sum item listed in the proposal, providing that the Contractor is diligently and satisfactorily pursuing full completion of such partially complete item in accordance with the approved job progress schedule.

END OF SECTION

SECTION 34 42 16

SIGNALS WIRE AND CABLE

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes Specifications for furnishing and installing wire and cable for the signal system. The intent of the Specification is that all cables supplied for this Project shall meet all AREMA standards.

1.2 RELATED SECTIONS

- A. SECTION 01 33 00 – Submittal Procedures
- B. SECTION 01 43 00 – Systems Quality Assurance
- C. SECTION 34 42 10 – Signals General Engineering and Design Requirements

1.3 QUALITY ASSURANCE

- A. The Contractor shall comply with the requirements of Division 1.
- B. Manufacturer Qualifications
 - 1. The manufacturer shall have at least 15 years of documented reliable experience in supplying vital-circuit signal cables of the type specified by this Contract with a minimum of 2,000,000 cable feet installed in the railroad or transit industry.
 - 2. The material and workmanship of the wire and cable shall be of the highest quality, assuring durability for the 40 year design life of the cable installation.
 - 3. The Contractor shall submit a list from the cable manufacturer, of the names of the railroads or transit agencies where the manufacturer's cables specified by this Contract have been installed.

1.4 SUBMITTALS

- A. Unless otherwise specified, all submittals by the Contractor shall be in accordance with SECTION 01 33 00 – Submittal Procedures and SECTION 34 42 10 – Signals General Engineering And Design Requirements.
 - 1. Drawings
 - a. Shop drawings and manufacturer's literature showing details of fabrication and technical data shall be submitted for each type of cable to be furnished. These documents shall be in the English language.
 - b. Working drawings showing specialized requirements for installation and termination shall be submitted.
 - c. Cable plans as detailed in SECTION 34 42 10 – Signals General Engineering And Design Requirements showing the locations and functions of all cables to be installed shall be submitted. These plans shall be included in the book of plans for each location.
 - 2. Wire and Cable Installation Plan

3. Test reports shall be submitted for all tests including:
 - a. Factory tests as specified herein on each completed length of cable
 - b. Appropriate factory test data on file for each similar type and size cable for each step in the manufacturing process and tests performed on samples in compliance with the referenced standards
 - c. Field tests after installation
 - d. Actual pulling tension measurements for each pull.
4. A 3-inch sample of each type of cable to be supplied shall be submitted
5. Delivery inspection report for all incoming material

1.5 DELIVERY, STORAGE AND HANDLING

- A. Each length of cable shall be wound on a separate reel. Reels shall be substantial enough to withstand reasonable handling and shall be so designed that the inner end of the cable shall be accessible but protected from injury. The diameter of the drum shall be at least 14 times the cable diameter to prevent damage to the cable during reeling. The arbor hole shall admit a spindle 2.5 inches in diameter without binding. The reels shall be designated and constructed as non-returnable when drum size and cable weight and volume permit.
- B. The Contractor shall inspect cables at time of delivery to the construction site to assure that no damage was done in shipping and that the specified cable was received. Every reel shall be inspected by the Contractor for physical damage such as nails driven into reels to secure shipping blocks, lagging or reel covering missing and cable and seals missing or damaged and a report shall be completed verifying that the reel was inspected and no damage was found. A copy of these inspection reports shall be submitted to the Project Manager. All damaged or rejected cable shall be replaced promptly by the Contractor at no cost to the Agency.
- C. Wires and cables shall be stored at the construction site on solid surfaces which shall adequately support the cable reels and shall be well drained and not allow accumulation of liquids, oils, or chemicals.
- D. The cable reels shall be aligned and protection provided so as not to allow the reel flanges to damage other reels. Adequate aisles and barricades shall provide accessibility but prevent construction equipment from damaging the cable reels.
- E. The Contractor shall pack and mark wire and cable in accordance with AREMA Signal Manual Part 10.3 (Wire and Cable), except as otherwise specified, or as Approved by the Agency.
- F. The Contractor shall ship, store, and handle material as specified in AREMA Signal Manual Part 10.4.1 (Recommended Instructions for Wire and Cable Installation and Maintenance), except as otherwise specified, or as Approved by the Agency.
- G. Cable reels shall be properly handled, i.e., by using a sling and spreader attached to a shaft through the reel hubs, or by cradling both flanges between lift truck forks. The reels shall not be lifted by the top reel flange or dropped from any height. Truck forks shall not touch cable surfaces on the reel. Reels shall always be rolled in the direction opposite the cable wind on the reel. Reels shall not be laid flat.
- H. Contractor shall seal both cable ends to prevent entrance of moisture during storage and handling prior to final cable termination.

PART 2 - PRODUCTS**2.1 SIGNAL WIRE AND CABLE****A. General**

1. The Contractor shall supply cable with insulating and jacketing materials capable of a 40-year average service life.
2. The Contractor shall supply cable suitable for installation at -20 degrees Celsius.
3. The capacitance of cables supplied by the Contractor shall be within the limits prescribed by the manufacturer of the equipment to which the cable is connected.
4. Cables may be manufactured as "composite" type where conductors of more than 1-gauge are wrapped in one overall jacket. If the Contractor opts to use this type of cable he will construct cables that comply with the Agency's standard configuration of conductors

B. Minimum voltage rating for both AC and DC

1. All cables shall be rated for 600 Volts minimum.
2. Power frequency track circuit cables shall be rated for 2000 Volts minimum.
3. Power bonds, crossbonds, and bond strand cable shall be rated for 2000 Volts minimum.

C. Conductors supplied by the Contractor shall be:

1. Sized to ensure operation of equipment based on the equipment loads and operating parameters for the systems in accordance with NEC and shall comply with AREMA Communications and Signals Manual Part 10.3.15 (Recommended Design Criteria for Insulated Signal Wire), except as otherwise specified, or as Approved by the Project Manager.
2. Case wire shall be used when the wire is located completely within a weather-protected housing. This wire shall be insulated with Ethylene Tetrafluoroethylene (ETFE) Fluorocarbon resin and shall comply with AREMA Communications and Signals Manual Part 10.3.14 (Recommended Design Criteria for Ethylene Tetrafluoroethylene Copolymer (ETFE) Insulated Signal Wire and Cable), except as otherwise specified, or as Approved by the Project Manager.
3. Coated conductors of annealed copper wire in accordance with ASTM B 33; Class C and Class D stranded conductors conforming to ASTM B 8 paragraph 1.2.4, Table 1 and Table 2; and Class G and Class H stranded conductors conforming to ASTM B173 paragraph 3.1.1, paragraph 3.1.2 and Table 1 as follows:
 - a. Equipment module, signal and instrumentation non-vital external wiring: No. 20 AWG minimum, Class C.
 - b. Power frequency track circuits: No. 6 AWG minimum, Class C.
 - c. Track switch machine operation and switch heater power: No. 6 AWG minimum, Class C.
 - d. Track switch machine control and indication: No. 14 AWG minimum, Class C.
 - e. Wayside signal circuits: No. 10 AWG minimum, Class D.

- f. Power bonds: C type, 250 MCM, Class G, bare.
 - g. Bond strand wire: No. 6 AWG minimum, Class H, for track circuit connections, and similar uses.
 - h. Signal bonds: C type, cadmium bronze, ASTM B 105, Alloy 80, bare stranded rope lay with one center rope of 19 wires surrounded by six ropes of 19 wires each, using wires of 0.125-inch with nominal cable diameter of 0.1875 inches.
 - i. All vital and other circuits: No. 16 AWG minimum, Class C.
- D. Exterior Cables
- 1. Except where interior type cable is specifically permitted, the Contractor shall use exterior cable for all circuits operating at or above 120 Volts AC/DC; for all power, signal, control, and instrumentation circuits installed along the wayside.
 - 2. Shall be certified for continuous operation at 90 degrees Celsius wet or dry
 - 3. Insulation
 - a. Single conductor cables and individual conductors of multiple conductor cables shall be insulated with a tight-fitting, clean-stripping, ozone-resistant ethylene-propylene rubber or other synthetic rubber vulcanized elastomer Approved by the Project Manager. Final insulation mixture shall be passed through an 80-mesh screen to ensure homogeneity.
 - b. The insulation shall not crack during installation at temperatures as low as -20 degrees Fahrenheit.
 - c. The average thickness of insulation shall not be less than that specified below. Minimum thickness at any point shall not be less than 90% of that specified. AC test voltages listed are at 60 Hz applied for 5 minutes, and DC test voltages are applied for 10 minutes. These cable tests shall comply with AREMA Communications and Signals Manual Part 10.3.19 (Recommended Design Criteria for Ethylene-Propylene Rubber Insulation for Wire and Cable), except as otherwise specified, or as Approved by the Project Manager.
 - 1) Insulation thickness and test voltages of single conductor cable prior to jacket application for circuits rated up to 2000 Volts shall be as shown in Table 1 of this Section.
 - 2) Insulation thickness and test voltages for individual conductors of multiple conductor cables on circuits rated up to 2000 Volts shall be as shown in Table 1.1 of this Section.
 - d. Physical and electrical characteristics shall conform to Table 6 of this Section when tested in accordance with NEMA WC 70/ICEA S-95-658 Section 6, as modified herein.
 - 4. Outer Jackets
 - a. Single conductor cables and multiple conductor cables shall be provided with outer jacket of applicable material as follows:

- 1) Cable jackets shall be of extruded black low density, high molecular weight Chlorosulfonated Polyethylene (HYPALON) and shall comply with AREMA Communications and Signals Manual Part 10.3.20 (Recommended Design Criteria for Neoprene, Chlorinated Polyethylene and Chlorosulfonated Polyethylene Jacketing for Wire and Cable), except as otherwise specified, or as Approved by the Agency. Physical and electrical characteristics conforming to Type 1, Class C, Grade E5 of ASTM D 1248 and Table 8 of this Section when tested in accordance with NEMA WC 70/ICEA S-95-658 Section 6.
- 2) Average jacket thickness on all cables shall be 65 mils minimum, and the average jacket thickness for the outer jacket on multiple conductor cables shall be in accordance with Table 2 of this Section. The minimum jacket thickness at any point shall not be less than 90% of that specified.

E. Interior Cables

1. Interior cables shall be used only for wiring inside cases. Wires running between two adjacent above ground piped connected relay cases will be considered interior cables.
2. Interior cables shall be certified for continuous operation at 90 degrees Celsius in wet or dry locations.
3. Interior cable insulation shall comply with the following:
 - a. Single conductor cables and individual conductors of multiple conductor cables shall be insulated with a tight-fitting, clean-stripping, ozone-resistant ethylene-propylene rubber or other synthetic rubber vulcanized elastomer Approved by the Project Manager. Final insulation mixture shall be passed through an 80-mesh screen to ensure homogeneity.
 - b. Average thickness of insulation shall not be less than that specified below. Minimum thickness at any point shall not be less than 90% of that specified.
 - c. Insulating thickness and test voltages of single conductor prior to jacket application, and individual conductors of multiple conductor cables for circuits rated up to 1000 Volts shall be as shown in Table 1.2 of this Section.
 - d. Physical and electrical characteristics shall be tested in accordance with NEMA WC 70/ICEA S-95-658 Section 6, as modified herein.
4. Outer Jackets
 - a. Jackets shall be of extruded black low density, high molecular weight Chlorosulfonated Polyethylene (HYPALON) material and shall be provided for:
 - 1) Single conductor cables
 - 2) Outer jacket of multiple conductor cables
 - b. Average jacket thickness on single conductor cables shall be 15 mils minimum.

- c. Average jacket thickness for outer or overall jacket on multiple conductor cables shall be 45 mils minimum.
 - d. The minimum jacket thickness at any point shall not be less than 90% of that specified.
- F. Assembly of Multiple Conductor Cables
- 1. Exterior multiple conductor cables
 - a. Shall be assembled in accordance with AREMA Communications and Signals Manual Part 10.3.16 (Recommended Design Criteria for Signal Cable, Non-Armored), paragraph F, and the jacket shall be as specified in paragraph G except as otherwise specified, or as Approved by the Project Manager.
 - 1) Cables shall also have a shock absorbing layer of non-hygroscopic extruded elastomeric material over the assembled conductors and fillers. The thickness shall be as shown in Table 3 of this Section.
 - 2) A pull cord shall be included beneath the cushion layer to provide for removal of the cushion layer for terminating the cable.
 - 3) Exterior type cables including single pair twisted cable shall be provided with a 10 mil minimum bronze tape beneath the outer jacket for rodent and other environmental protection in accordance AREMA Communications and Signals Manual Part 10.3.17 (Recommended Design Criteria for Signal Cable, Armored), paragraph F, except as otherwise specified, or as Approved by the Project Manager.
 - 4) Shall be equipped with additional shielding of metal tape or metal braid appropriate for installation and service conditions, and in accordance AREMA Communications and Signals Manual Part 10.3.17 (Recommended Design Criteria for Signal Cable, Armored), paragraph F, except as otherwise specified, or as Approved by the Project Manager.
 - 2. Two conductor twisted pair cable, and multiple twisted pair cables shall be assembled as specified above for multiple conductor cables.
 - 3. Interior multiple conductor cables shall be assembled in accordance with AREMA Communications and Signals Manual Part 10.3.16 (Recommended Design Criteria for Signal Cable, Non-Armored), paragraph F, and the jacket shall be as specified in paragraph G except as otherwise specified, or as Approved by the Project Manager.
- G. Conductor Identification
- 1. For twisted pair, insulation shall be identified as white on one conductor and black on the other conductor.
 - 2. Except as otherwise specified, each insulated conductor within multiple conductor cables shall be identified with a specific number or shall have a different color or tracer color combination. Color code of multiple conductor control cables shall conform to AREMA Communications and Signals Manual Part 10.3.14 (Recommended Design Criteria for Ethylene Tetrafluorethylene Copolymer (ETFE) Insulated Signal Wire and Cable) Table 10314-5: Color Code of Individual Wires of Multi Conductor Cables.

- H. The Contractor shall ensure that the cables are permanently identified as to manufacturer, year of manufacture, insulation type, conductor size, and voltage rating at intervals of not greater than 3 feet with non-hygroscopic marker tape under the jacket and parallel to the longitudinal axis of the cable and subject to approval by the Project Manager.

2.2 POWER CABLE

- A. The power cables for signal system and instrument housings shall be sized to carry the design loads and fault currents without exceeding the allowable cable temperatures. The cables shall be stranded copper conductors of minimum size #6 AWG (minimum 3C#6) and the conductors shall be ethylene-propylene rubber insulated in accordance with NEMA WC 70/ICEA S-95-658 and ASTM D 2802. The insulation level shall be consistent with the system nominal voltage. The cables shall be furnished with jackets of heavy duty extruded black low density, high molecular weight Chlorosulfonated Polyethylene (HYPALON) in accordance with ASTM D 752.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. The Contractor shall verify that the installation design is correct and adequate for the cables to be installed. The Contractor shall assure that conduit size, conduit fill, conduit bend radii, manhole spacing, manhole size, raceways, ducts and associated hardware are proper for the intended installation.
- B. The Contractor shall install wires and cables in accordance with cable handling and pulling practice as defined by AREMA Communications and Signals Manual Part 10.4.1 (Recommended Instructions for Wire and Cable Installation and Maintenance), and the cable manufacturers' recommendations.
- C. The Contractor shall utilize only installers who are qualified and experienced in handling and installing underground cable in conduit. Experienced supervision shall be provided to ensure that all necessary precautions are taken and that the installation is in accordance with the requirements of this Section.
- D. The Contractor shall not exceed the minimum bending radius as permitted by NEMA WC 70/ICEA S-95-658 Appendix F or cable manufacturer. Cables shall not be subjected to tensions more than the manufacturer's recommendation.
- E. Direct buried cable should be avoided, but if required and Approved by the Project Manager, it shall be installed at a minimum depth of at least 30 inches or as required by local codes. The Contractor shall prevent cable from coming into contact with sharp objects, and damage to cable insulation during installation. Notify the Agency 24 hours prior to cable installation.
- F. Except as provided for in 3.1 E, all cable shall be installed in conduit.
- G. The Contractor shall verify that the raceway conduit system is free of obstructions by pulling a suitable wire brush, swab and mandrel through it to remove extraneous matter.
- H. The Contractor shall ensure that the raceway conduit system is dry before installation of cable and use lubricant approved by the cable manufacturer to facilitate pulling cable. The Contractor shall clean residue from conductors, boxes and equipment after the pull is made.
- I. Cables inside manholes shall run on racks. Racks shall be fiberglass or have porcelain or fiberglass cable-support insulators made for that purpose. Metal parts shall be bonded to the manhole ground rod.

- J. Supporting racks shall have a maximum spacing of 3 feet and be installed to avoid excessive weight or pressures on the cable insulation. Racks shall also prevent cable damage from short circuit forces. Cables shall be arranged in not more than two layers and secured with cable ties or straps.
- K. The Contractor shall submit to the Project Manager a Wire and Cable Installation Plan. This plan shall contain all wire and cable installation and pulling calculations, and for each conduit run where cable is to be installed using power winches, the following shall be included:
1. The equipment set-up including sheave and reel diameter, and installation methods including cable protection methods during installation
 2. A detailed installation description for conductors to be installed
- L. The Contractor shall calculate maximum cable lengths and allowable pulling tensions, and minimum bend radius for each type of cable to be installed to avoid exceeding manufacturer's installation recommendations. Consideration shall be given to the following parameters:
1. Fill
 2. Friction
 3. Clearance
 4. Configuration
 5. Jam ratio of the cables and conduit
 6. Weight correction factor
 7. Bend radii
 8. Training of the cables on entering and exiting the conduits
 9. Maximum allowable tension
 10. Sidewall load
 11. Weight of the cables

These factors shall be calculated for each pull as required and the Contractor shall not exceed the maximum allowable values of sidewall pressure, pulling strain on conductors or sheath, limits of pulling device and pulling tension.

- M. In general, the Contractor shall not exceed the following guidelines:
1. The maximum pulling strain on the cable with a pulling eye attached to the conductors is a function of the conductor area as follows:
 $TM = 0.008 \times n \times CM$
Where:
TM = Maximum tension pounds
n = number of conductors
CM = area of each conductor (circular mils)
 2. When a basket-weave grip is used in lieu of a pulling eye, the maximum tension shall not exceed the value calculated for the pulling eye method or 1,000 pounds per grip, whichever is less.

3. The sidewall pressure loads shall not exceed 300 pounds/foot or the Wire and Cable Manufacturer's recommendation, whichever is less.
 4. The jam ratio shall not fall between 2.8 and 3.2.
 5. The coefficient of friction for the cables with lubrication shall be taken to be 0.35.
- N. Suitable pulling apparatus in good working condition shall be used. The Contractor shall demonstrate the operation of the pulling apparatus for the Project Manager's review. It shall be provided with a smooth variable speed control for pulling. For plastic conduit, a manila hemp pulling line shall be used. Nylon line shall not be used due to its elongation under tension. A dynamometer to measure the pulling tensions shall be used by the Contractor at the pulling end of the installation and the measured value shall be recorded for each pull.
- O. Proper procedures for feeding cable into the conduit shall be established by the Contractor. Feed-in tubes, sheaves, cable reel jacks and other appropriate tools necessary to provide proper bending radii and minimal friction during installation shall be used. Direction or training of the cables on entering and exiting the conduit shall coincide with other parts of the installation arrangement so that the cable is not damaged or over-stressed.
- P. The Contractor shall use only the wire and cable manufacturer's approved pulling compound or lubricant compatible with the cable. The lubricant shall be used in ample quantity to reduce friction and applied in such a manner that the cable is lubricated throughout the entire length being pulled through the conduit. The lubricant shall be non-hygroscopic and vermin-proof.
- Q. The installation shall be in accordance with the Contractor's approved Wire and Cable Installation Plan, which shall include the following considerations:
1. Spare wires and cables shall be installed at the same time that the active wires and cables are being installed.
 2. Cables shall not be pulled into a conduit that already contains conductors.
 3. If it becomes necessary to remove a cable from a conduit, all cables in that conduit shall be removed. Cable removed from conduit shall not be reinstalled or used elsewhere.
 4. Two-way communication between pulling and feed ends shall be established before and during the installation.
 5. Pulling shall be done at a constant velocity, not less than 15 feet per minute nor more than 50 feet per minute. The pull shall not be stopped once started unless absolutely necessary.
 6. Cable shall be protected after installation and prior to terminating or splicing.
 7. After pulling, the tension end of the cable damaged in the pulling process shall be cut off.
 8. All cables shall be identified.
- R. Exposed cable shall not be permitted along the wayside.
- S. The Contractor shall not allow wires to cross one another when pulled into a conduit. The Contractor shall prevent kinking in conduit fittings or boxes.

- T. The Contractor shall not pull cable in trays or troughs. Cable shall be laid, with a minimum amount of crossover, in the trays and troughs and secured at least every 3 feet, and shall not be pulled tightly around bends. Conduits for cables entering or leaving trays shall be rigidly attached and supported at their ends by suitable brackets and conduit straps on the side of the trays.
- U. All exposed wires and cables entering or leaving relay cases, junction boxes and cable transition points shall be protected from abrasion. Chase nipples shall be provided in drilled or punched openings in equipment housings and junction boxes located trackside. Openings in equipment enclosures and junction boxes shall have split ring plastic grommets.
- V. The Contractor shall seal all openings in equipment enclosures and junction boxes where exposed cables enter the enclosure or box. A resilient sealing compound made expressly for the purpose shall be installed after the cables are in place.
- W. Open wiring on individual equipment racks shall be neatly arranged, bundled and tied approximately every 3 inches with nylon straps.
- X. Cable installed in conduit, regardless of length, shall not exceed the maximum fill recommendations of the manufacturer and the requirements of the NEC and local codes. Where the aforementioned codes do not apply, the maximum fill shall not exceed 60%.
- Y. The cable installation in manholes and pull boxes shall not interfere with the future use of or access to unused conduit.
- Z. Signal system cables shall not be combined in the same conduit with cables of other Systems elements.
- AA. Cable Duct and Manhole Access Points.
 - 1. Each cable duct to be used for the routing of signal cable shall be blown or swabbed dry. All cables to be placed in one duct shall be installed simultaneously. Extreme care must be used in installing cables so as to avoid twisting, kinking, or in any way injuring the cable or its sheath.
 - 2. The ends of the cable shall be immediately sealed until such time as the terminating and protecting of the cable in the manholes, cable pits, cases and relay cases is effected. All conduits entering manholes, or cable slots between cable pits and housings, shall be filled with sealing compound.
 - 3. When necessary, the Contractor shall pump water out of manholes, cable pits, and pull chambers before installing any cables and shall be responsible for maintaining manholes and pull chambers in a dry condition while the cables are being pulled.
 - 4. Cables shall be installed with slack in pull boxes. Pulling cables shall be attached to the conductors as well.

3.2 SPLICES AND TERMINATIONS

- A. Wires and cables shall be continuous between relay cases; between relay case and the intended termination point at the wayside or station equipment, and between other termination points. Splices shall not be permitted. If signal cable(s) cannot be run continuously between instrument enclosures shown on the contract drawings, the Contractor shall install an intermediate case for termination of such cables at no additional cost to the Agency.
- B. Terminations for 600 Volt Wire and Cable

1. Cables shall be trained into final position while observing minimum bending radii. Slack shall be provided at all terminals in an amount sufficient for at least two re-terminations.
 2. Wire and cables where connected directly to signal equipment shall be of sufficient length to allow access for removal and inspection of equipment. Wires and cables shall be continuous, without splices, between terminals within a housing and enclosure or piece of equipment.
 3. Termination work shall be conducted under clean and dry conditions.
 4. All wires and cables at the entrance rack and beyond, leaving the case shall be terminated on an AREMA (AAR) terminal block. Compression-type insulated terminal connections to terminal blocks shall use a single washer on top of the terminal. Wire eyes require two washers for one eye, three washers for two eyes. Connections shall be completed with double nuts and torqued to the rated value of the nut. All incoming cables shall terminate at the entrance rack.
 5. There shall be no more than two wires on one AREMA (AAR) terminal binding post.
 6. Intra-rack wires, beyond the entrance rack, may terminate on WAGO type terminals. The Contractor shall follow the manufacturer's recommendation when terminating wires on these type terminals.
 7. All wires and cables shall be identified during the termination process.
 8. All wires which are terminated on AREMA binding posts shall be fitted with an acceptable insulated crimped type terminal as described in AREMA Communications and Signals Manual Part 14.1.1 (Recommended Design Criteria and Functional/Operating Guidelines for Solderless Crimp-Type Wire Terminals for Use in Wiring Signal Apparatus). All terminations shall use tinned connections.
 9. The wire terminals shall be installed only with tools and techniques recommended by the terminal manufacturer and submitted to the Project Manager. Crimp tools shall be of the ratchet-type that do not release unless the wire terminal has been compressed to the proper thickness. Crimp tool shall be re-calibrated at regular, specified intervals using gauges provided by the crimp tool manufacturer.
 10. Terminal connections other than those described in 3.2 B 8 shall be UL listed and have capacity and insulation voltage ratings of not less than the ratings of the wire or cable terminated. All terminations shall use tinned connections.
 - a. Terminals for No. 10 and smaller wire: Vinyl-insulated, electro-tin-plated, electrolytic copper locking spade.
 - b. Terminals for No. 8 to 3/0 wire - Compression, tin-plated copper.
 - c. Terminals for No. 4/0 and larger wire - Long-barrel, tin-plated copper, compression type with two bolting holes in the pad (NEMA 2-hole pad).
- C. Other material including lugs, terminations, exothermic welds and bare jumpers shall be as manufactured by Erico Products or an approved equal.
- D. If terminations are not made immediately after installation, ends of cable shall be sealed as recommended by the manufacturer to prevent entrance of moisture.
- E. Spare conductors shall be tagged and terminated on spare terminal posts in each relay case or other enclosure.

- F. The Contractor shall separate signaling cables from parallel runs of AC feeder cable(s) where adjacent locations are fed from one AC service location, and parallel runs of feeder cables for snow melters.

3.3 IDENTIFICATION

- A. The Contractor shall comply with the requirements of this Section for wire and cable identification.
1. All single and multiple-conductor wires and cables shall be identified whenever they enter or leave a junction box, manhole, housing, or enclosure, and at all terminals.
 2. Permanent non-conducting marking tags fastened securely to the wires and cables shall be used for identification.
 3. Wire designations shall consistently conform to an overall scheme, submitted to the Project Manager for Approval, to indicate location, circuit, device, wire number, terminal branch, position, etc., in accordance with AREMA (AAR) symbols and nomenclature.
 4. Signal equipment room, case, case and junction box wires shall be identified with tags which show:
 - a. The wire's origin
 - b. Circuit nomenclature (wire name)
 - c. The wire's destination

3.4 SPARE CONDUCTORS

- A. Each multiple-conductor cable shall have 10% spares or a minimum of two spare conductors, whichever is greater, with the following exceptions:
1. It shall not be necessary to provide spare conductors for track circuit connections. That is, spare conductors are not required for the stranded cable that connects the running rails to the first termination, junction box or instrument case. Spare conductors are required for all track leads beyond the first termination from the track.

3.5 TESTING

- A. Wire and Cable
1. Control Testing
 - a. The Contractor shall perform the following control tests during manufacture.
 - 1) Voltage and insulation resistance tests on cables in accordance with Sections 2.2 and 2.3 of WC 53/ICEA T-27-581, modified as follows:
 - a) Test potentials for both AC and DC as specified herein.
 - b) All immersion tests shall be done after 24 hours minimum immersion.
 - c) Individual conductors of multiple conductor cables tested before assembly as specified for single conductor cables.

- 2) Shield isolation test on all combinations of pairs and over-all shield. After one minute at 500 Volts, the minimum resistance shall be 35,000 Megohms per 1,000 feet.
 - 3) Conductor resistance tests on all cables in accordance with Section 2.1 of NEMA WC 53/ICEA T-27-581.
 - 4) Physical characteristic tests on at least one sample from each type and size of cable in accordance with Section 4 of NEMA WC 53/ICEA T-27-581.
 - 5) AC voltage withstand test on each shipping reel of finished cable at the test insulation voltage for 1 minute prior to shipment.
2. Wire and Cable Insulation Qualification Tests
- a. All cables supplied must meet the test specifications outlined in AREMA Communications and Signals Manual Part 10.3 (Wire and Cable), NEMA WC 53/ ICEA T-27-581 and NEMA WC 70/ICEA S-95-658 except as otherwise specified, or as Approved by the Project Manager.
 - b. The wire and cable manufacturers shall have met the following qualification requirements for insulation in order to be approved for use on signal circuits.
 - 1) No insulation failure shall have occurred during these tests.
 - 2) Full documentation shall be submitted on the tests and the test results.
 - 3) The insulation shall be consistently uniform and established as suitable for service at potentials up to 15,000 Volts.
 - 4) The dielectric strength stability shall have been demonstrated by voltage-aging a test sample of a single conductor AWG 14 or larger size wire with 80-mil or thicker insulation, shielded with the shield grounded. The cable shall be tested in free air with a minimum of 10 feet between terminals. One of the voltage stresses listed in Table 4 (Voltage Aging {Dry} Requirements) of this Section shall have been applied to voltage-age the sample.
 - 5) The test sample shall then be subjected to a 60 Hz step-voltage test. Test voltages of 60 Hz AC increased in 10 kV steps for 5 minutes at each step shall be applied to the voltage-aged sample until breakdown occurs. The test shall start at the test voltage level used in the voltage-aging test. Breakdown shall be at a test voltage level greater than 350 Volts/mil. The 490 Volts/mil test sample is excluded from this test.
 - 6) Thermal aging is determined by the insulation being tested in a circulating-air oven using 80-mil-thick slabs and having an elongation not less than 50% after a minimum aging time of 25 hours at 135 degrees Celsius and 100 hours at 121 degrees Celsius.

- 7) To establish moisture-resistance characteristics, an insulated conductor sample, similar to that used for the voltage-aging test, shall be used. The test sample shall be at least 10 feet long, shall be immersed in water with the shield grounded and tested at room temperature. The insulated conductor without any coverings over the insulation shall be continuously energized with one of the voltage stresses listed in Table 5 (Voltage Aging {Wet} Requirements) of this Section applied with no failures occurring.
 - 8) When tested with methods described in NEMA WC 70/ICEA S-95-658 Section 6, as modified herein and the procedures specified herein, the cable insulation shall meet the requirements listed in Table 6 (Ethylene-Propylene Rubber Insulation, Physical and Electrical Characteristics) of this Section and AREMA Communications and Signals Manual Part 10.3.15 (Recommended Design Criteria for Insulated Signal Wire) except as otherwise specified, or as Approved by the Project Manager with no failures occurring.
 - 9) When tested with methods described in NEMA HP-100.2 and the procedures specified herein, the case wiring insulation shall have the guaranteed physical and electrical characteristics shown in Table 7 (Ethylene Tetra Fluoroethylene Copolymer (ETFE) Physical and Electrical Characteristics) of this Section and AREMA Communications and Signals Manual Part 10.3.14 (Recommended Design Criteria for Ethylene Tetrafluoroethylene Copolymer (ETFE) Insulated Signal Wire and Cable) except as otherwise specified, or as Approved by the Project Manager with no failures occurring.
 - 10) When tested with methods described in NEMA WC 70/ICEA S-95-658 Section 6, as modified herein and the procedures specified herein, the jacket material for all insulated cable shall meet the requirements listed in Table 8 (Chlorosulfonated Polyethylene (HYPALON) Jacket Physical and Electrical Characteristics) of this Section and AREMA Communications and Signals Manual Part 10.3.20 (Recommended Design Criteria for Neoprene, Chlorinated Polyethylene and Chlorosulfonated Polyethylene Jacketing for Wire and Cable) except as otherwise specified, or as Approved by the Project Manager with no failures occurring.
3. Production Tests
- a. Production tests shall be made on samples selected at random at the place of production in accordance with the requirements of NEMA WC 70/ICEA S-95-658 Section 6, as modified herein. Each test sample shall be taken from the accessible end of different reels. Each reel selected and the corresponding sample shall be identified. The number and lengths of samples shall be as specified under the individual test. The test methods and the quantities of samples shall be those required in NEMA WC 70/ICEA S-95-658 Section 6, as modified herein. All applicable tests for the cable materials and cable construction specified shall be performed.
 - b. The Contractor shall require the wire and cable manufacturers to provide at their expense, at the point of production, equipment and labor for making any or all of the following tests:
 - 1) Conductor size and physical characteristics

- 2) Insulation, voltage and resistance tests
 - 3) Physical dimension tests
 - 4) Special tests on insulation and jacket materials. Final voltage, insulation resistance and conductor resistance tests on wires and cables on shipping reels.
 - 5) Electrical and physical certified reports for all tests shall be submitted to the Project Manager for the finished single and multiple-conductor cables prior to the time of shipment to the work site. Each test document shall, in addition to the test results, indicate the date the tests were performed and the signature of the person who conducted the tests.
 - 6) Cable that does not meet the test requirements set forth in this Section shall be rejected. Wire or cable that shows defects or noncompliance with these requirements after arrival at the Site may be rejected by the Contractor or the Project Manager. The Contractor shall, upon request, advise the Project Manager regarding the disposition of the wire or cable in question and pay all transportation charges on the rejected and replacement material.
- c. The following tests shall be made on all insulated conductors and prior to application of outer jacket or braid and prior to cabling or twisting.
- 1) Dry "Spark" Test: Every individual length of insulated conductor shall be passed through high-voltage test electrodes energized with an AC Spark Test voltage adjusted to a minimum value of that shown in Table 1, 1.1 and 1.2 as appropriate (Wire Insulation Thicknesses and Test Voltages).
 - 2) AC Voltage Test (Wet Tank): Every individual length of insulated conductor shall be subjected to and withstand without failure for 5 minutes the 60 Hz AC test voltages listed in Table 1, 1.1 and 1.2 as appropriate (Wire Insulation Thicknesses and Test Voltages). Voltage shall be applied between the insulated conductor immersed in the test tank and the water. This test shall be made while submerged after not less than 24 hours immersion in water. There shall be no signs of puncture, overheating, or self-healing of punctures.
 - 3) Insulation Resistance Testing: Every individual length of insulated conductor shall be subjected to an insulation resistance test. This test shall be made while each conductor is submerged, and after not less than 24 hours immersion in water. The insulation resistance shall not be less than the value of R as calculated in the following industry standard formula, corrected to 15.6 degrees Celsius.
$$R = K \log_{10} D/d$$

Where:

R = Insulation resistance in megohms/1,000 feet at 15.6 degrees Celsius
K = 35,000 Megohms/1,000 feet (for cables) and 50,000 Megohms/1,000 feet (for case wiring)
D = Diameter over conductor insulation
d = Diameter under conductor insulation

- 4) DC Voltage Test: Every individual length of insulated conductor shall be subjected to and withstand the DC test voltage shown in Table 1, 1.1 and 1.2 as appropriate (Wire Insulation Thickness and Test Voltages) for 5 minutes. This test shall be made while each conductor is submerged, and after not less than 24 hours immersion in water. For each sample tested, spark tests, AC voltage tests and insulation resistance tests shall be completed before DC voltage tests are conducted. Sufficient time shall be allowed between this test and the insulation-resistance test to prevent polarization from affecting the results.

3.6 FINAL TESTS

- A. For the AC voltage test, every individual length of finished cable, while on the shipping reel, shall be subjected to a test voltage of Table 1, 1.1 and 1.2 as appropriate (Wire Insulation Thickness and Test Voltages) between conductors and ground and two times the test voltage between conductors. This test voltage shall be applied between adjacent insulated conductors and between adjacent layers of insulated conductors in the cable for a time period of 1 minute. Cables without a metallic armor tape shall be immersed in water for a period of not less than 6 hours prior to this test. Metallic armor type cables shall use the metal tape as ground, and water immersion is not required. Any metallic shield or armor shall be connected to ground potential.
- B. Every individual length of completed cable, following the 1 minute AC test, shall have an insulation resistance not less than the value specified in Table 6 (Ethylene-Propylene Rubber Insulation, Physical and Electrical Characteristics) and AREMA Communications and Signals Manual Part 10.3.15 (Recommended Design Criteria for Insulated Signal Wire) except as otherwise specified, or as Approved by the Project Manager.
- C. Every individual length of completed case wire, following the 1 minute AC test, shall have an insulation resistance not less than the value specified in Table 7 (Ethylene Tetra Fluoroethylene Copolymer (ETFE) Physical and Electrical Characteristics) and AREMA Communications and Signals Manual Part 10.3.14 (Recommended Design Criteria for Ethylene Tetrafluoroethylene Copolymer (ETFE) Insulated Signal Wire and Cable) except as otherwise specified, or as Approved by the Project Manager.
- D. Every individual length of completed cable and case wire shall have the DC resistance of each conductor measured and recorded. This value shall conform to NEMA WC 53/ ICEA T-27-581, Paragraph 2.1.
- E. Every individual length of completed shielded cable shall be tested for shield continuity.

**TABLE 1
WIRE INSULATION THICKNESSES AND TEST VOLTAGES
SINGLE CONDUCTOR EXTERIOR CABLES**

CONDUCTOR SIZE AWG	THICKNESS OF INSULATION	TEST VOLTAGE (KVAC RMS @ 60 Hz for 5 minutes)	TEST VOLTAGE (KVDC for 5 minutes)	TEST VOLTAGE (KVAC Spark Test)
14 to 9 AWG	80 mils	8.5	25.5	15.0
8 to 2 AWG	95 mils	10.0	30.0	17.5
1 to 4/0 AWG	110 mils	10.0	30.0	17.5
225 to 500 MCM	125 mils	11.5	34.5	20.0
525 to 2000 MCM	140 mils	11.5	34.5	22.5

**TABLE 1.1
WIRE INSULATION THICKNESSES AND TEST VOLTAGES
CONDUCTORS OF MULTI-CONDUCTOR EXTERIOR CABLES**

CONDUCTOR SIZE AWG	THICKNESS OF INSULATION	TEST VOLTAGE (KVAC RMS @ 60 Hz for 5 minutes)	TEST VOLTAGE (KVDC for 5 minutes)	TEST VOLTAGE (KVAC Spark Test)
20 to 18 AWG	45 mils	6.0	18.0	10.0
16 AWG	60 mils	7.5	22.5	12.5
14 to 9 AWG	80 mils	8.5	25.5	15.0
8 to 2 AWG	95 mils	10.0	30.0	17.5
1 to 4/0 AWG	110 mils	11.5	34.5	20.0

**TABLE 1.2
WIRE INSULATION THICKNESSES AND TEST VOLTAGES
CONDUCTORS OF INTERIOR CABLES**

CONDUCTOR SIZE AWG	THICKNESS OF INSULATION	TEST VOLTAGE (KVAC RMS @ 60 Hz for 5 minutes)	TEST VOLTAGE (KVDC for 5 minutes)	TEST VOLTAGE (KVAC Spark Test)
20 to 14 AWG	30 mils	3.5	10.5	7.5
12 to 9 AWG	45 mils	6.0	18.0	10.0

**TABLE 2
JACKET THICKNESS**

CALCULATED CORE DIAMETER -- INCHES	AVERAGE THICKNESS POLYETHYLENE JACKET
0 to 0.425	65 mils
0.426 to 0.700	80 mils
0.701 to 1.050	95 mils
1.051 to 1.500	110 mils
1.501 to 3.000	140 mils

**TABLE 3
CUSHION LAYER THICKNESS**

CALCULATED CORE DIAMETER -- INCHES	AVERAGE CUSHION LAYER THICKNESS
0 to 1.500	47 mils
1.501 and larger	62 mils

**TABLE 4
VOLTAGE AGING {DRY} TEST REQUIREMENTS**

TEST VOLTAGE 60 HZ AC VOLTS/MIL	AGING TIME (DURATION)
490 VAC for	6 months or
315 VAC for	1 year or
225 VAC for	2 years or
180 VAC for	3 years or
135 VAC for	5 years

**TABLE 5
VOLTAGE AGING {WET} TEST REQUIREMENTS**

TEST VOLTAGE 60 HZ AC VOLTS/MIL	AGING TIME (DURATION)
325 VAC for	2 months or
280 VAC for	3 months or
240 VAC for	4 months or
200 VAC for	6 months

**TABLE 6
ETHYLENE-PROPYLENE RUBBER INSULATION
PHYSICAL AND ELECTRICAL CHARACTERISTICS**

CHARACTERISTIC	TEST REQUIREMENT
Physical Requirements: Unaged tensile strength at rupture, minimum psi	1,200
Unaged tensile stress at 200% elongation, minimum psi	600
Unaged elongation at rupture, minimum percent	300
Unaged set in 2-inch gauge length, maximum percent	25
Aging Requirements Either (Circulating hot air oven test, 168 hours, 121 degrees Celsius): Tensile strength, minimum percent of unaged value	90
Elongation, minimum percent of unaged value	85
30 Days - Elongation, minimum percent of unaged value	80
60 Days - Elongation, minimum percent of unaged value	75
90 Days - Elongation, minimum percent of unaged value	70
And (Air-pressure heat test , 42 hours, 127 degrees Celsius, 80 psi) Tensile strength, minimum percent of unaged value	60
Elongation, minimum percent of unaged value	50
Or (Oxygen-pressure test, 168 hours, 80 degrees Celsius, 300 psi) Tensile strength, minimum percent of unaged value	90
Elongation, minimum percent of unaged value	85
Hot Creep Test (at 150 degrees Celsius): Elongation, maximum percent of unaged value	50
Set, maximum percent of unaged value	5
Insulation Resistance Constant (at 15.6 degrees Celsius): megaohms-1,000 feet, minimum	35,000
Mechanical Water Absorption (Gravimetric Method): 7 days 70 degrees Celsius, maximum mg per square inch	8
Accelerated Water Absorption (1-day immersion, maximum percent, with 80 Volts/mil measurement stress Dielectric constant 60 Hz @ 90 degrees Celsius):	4.0
Accelerated Water Absorption (Increase in dielectric constant): 1-14 days immersion, maximum percent	1.5
7-14 days immersion, maximum percent	1.0
1-90 days immersion, maximum percent	2.0
Accelerated Insulation Resistance Stability (at 90 degrees Celsius): 1-day immersion, minimum percent	1.0
90-day immersion, minimum percent	1.0
Cold Bend Requirement (1 hour at -40 degrees Celsius):	No Cracks
Specific Surface Resistivity (minimum Megaohms per NEMA WC 53/ ICEA T-27-581, Paragraph 2.8):	200,000
Ozone Resistance (168 hours @ 250 ppm concentration):	No Cracks

**TABLE 7
ETHYLENE TETRA FLUOROETHYLENE COPOLYMER (ETFE)
PHYSICAL AND ELECTRIC CHARACTERISTICS**

CHARACTERISTIC	TEST REQUIREMENT
Physical Requirements: Tensile strength, minimum psi Elongation at rupture, minimum percent	5,000 150
Aging Requirements (Air oven, 168 hours, 180 degrees Celsius): Tensile strength, minimum percent of unaged value Elongation at rupture minimum percent of unaged value	80 80
Oil immersion (168 hours, 150 degrees Celsius): Tensile strength, minimum percent of unaged value Elongation, minimum percent of unaged value	85 85
Mechanical Water Absorption (Gravimetric Method): 7 days – 70 degrees Celsius, maximum mg. per square inch	1.5
Accelerated Water Absorption (40 Volts per mil of insulation thickness at 90 degrees Celsius): Dielectric constant after 1 day, minimum Increase in capacitance after 1 to 14 days, maximum percent Increase in capacitance after 7 to 14 days, maximum percent Stability factor after 14 days, maximum	2.7 4.5 1.5 0.2
Cold Bend Requirements (4 hour at -65 degrees Celsius):	No Cracks
Ozone Resistance (24 hours in 150 ppm ozone):	No Cracks
Flame Resistance (IEEE 383):	Pass
Oxygen Index (Minimum percent):	28
Insulation Resistance (at 15.6 degrees Celsius): Megaohms-1,000 feet minimum	50,000

**TABLE 8
CHLOROSULFONATED POLYETHYLENE (HYPALON) OUTER JACKET
PHYSICAL AND ELECTRIC CHARACTERISTICS**

CHARACTERISTIC	TEST REQUIREMENT
Physical Requirements: Unaged tensile strength at rupture, minimum psi Unaged tensile stress at 200% elongation, minimum psi Unaged elongation at rupture, minimum percent Unaged set in 2-inch gauge length, maximum %	1,800 500 300 20
Aging Requirements (Air oven, 168 hours, 100 degrees Celsius): Tensile strength, minimum percent of unaged value Elongation at rupture minimum percent of unaged value (Air oven, 42 hours, 127 degrees Celsius): Tensile strength, minimum percent of unaged value Elongation at rupture minimum percent of unaged value	50 50 50 50
Oil immersion (18 hours, 121 degrees Celsius ASTM No. 2 oil): Tensile strength, minimum percent of unaged value Elongation, minimum percent of unaged value	60 60
Mechanical Water Absorption (Gravimetric Method): 7 days – 70 degrees Celsius, maximum mg. per square inch	35
Cold Bend Requirements (24 hour at -35 degrees Celsius):	No Cracks
Ozone Resistance (24 hours in 150 ppm ozone):	No Cracks
Flame Resistance (UL 1581 FT2):	Pass

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

- A. The quantities of accepted work will be measured in the following units. All measurements will be plan measure except for authorized changes.

1. Description: Lump Sum

4.2 PAYMENT

- A. Payment will be made at the respective unit or lump-sum price listed in the proposal and shall be full compensation for all labor, materials, and equipment necessary to complete the respective unit in place. There will be no separate measurement or payment for any item of work not specifically identified and listed in the proposal, and all such work shall be considered a subsidiary item with all costs pertaining thereto included in the prices for other items listed in the proposal. At the Engineer's option, partial payment may be made for any lump sum item listed in the proposal, providing that the Contractor is diligently and satisfactorily pursuing full completion of such partially complete item in accordance with the approved job progress schedule.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 34 42 19**SIGNALS MICROPROCESSOR-SYSTEMS****PART 1 - GENERAL****1.1 SUMMARY**

- A. This Section includes requirements for furnishing and installing microprocessor-based systems, including:
 - 1. Vital interlocking microprocessors;
 - 2. Microprocessor "test set"
 - 3. Event recorders
- B. The intent of the specification is to eliminate the use of both vital and non-vital relays, to the maximum extent possible, through the use of microprocessors.

1.2 RELATED SECTIONS

- A. SECTION 01 33 00 – Submittal Procedures
- B. SECTION 01 43 00 –Systems Quality Assurance
- C. SECTION 34 42 25 – Signals Relays and Plugboards
- D. SECTION 34 42 68 – Signals Circuit and Operational Requirements
- E. SECTION 34 42 72 – Signals Spare Parts, Manuals, and Training
- F. SECTION 34 42 76 – Signals Tests and Inspections

1.3 REFERENCES

- A. American Railway Engineering and Maintenance-of-Way Association, Communications & Signals Manual of Recommended Practice [AREMA C&S Manual]
 - 1. AREMA C&S Manual, Part 2.2.12 – Recommended Functional/Operating Guidelines for Vital Software-Based Interlocking Systems
 - 2. AREMA C&S MANUAL, PART 1.5.1 – Recommended Instructions for the Installation and Maintenance of Solid State Equipment.
 - 3. AREMA C&S MANUAL, PART 11.2.1 – Recommended General Practices for Electrical Surge Protection of Signal Systems.
 - 4. AREMA C&S MANUAL, PART 16.2 - All Recommended Symbols.

1.4 SUBMITTALS

- A. Vital Microprocessor Product Data: Submit product information for the microprocessor. Include all product data, assembly drawings, circuits, parts lists, and printed circuit board layouts. Include a functional block diagram for the vital microprocessor system components. The Contractor shall demonstrate the proposed microprocessor interlocking equipment has been successfully installed and in service in similar applications.

- B. Event Recorder Product Data: Submit product data for the event recorder, including cabling and all supporting equipment.

1.5 QUALITY ASSURANCE

- A. The Contractor shall comply with the requirements of Division 1.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. General: Microprocessor-based systems shall operate:
 - 1. In accordance with the environmental requirements specified in Section 01 XX 0 – Signals and Communications Product Requirements
 - 2. Without forced air ventilation
 - 3. Maintained by a traditional battery-rectifier supply. A requirement for a special power supply or UPS is not acceptable. Connections to external circuits shall be designed to interface to standard signal equipment operating at normal voltages for the type of equipment.
- B. Microprocessor Units
 - 1. Equipment shall be rack mounted in card file modules, complete with accessories, and shall be modular in design.
 - 2. Utilize keying to prevent improper insertion of circuit boards.
 - 3. Provide the capability to communicate with other systems, both vitally and non-vitally, as required by the specific application.
 - 4. Plug-in printed circuit cards shall be used wherever possible and they shall be keyed or configured such that a card cannot be installed in the incorrect position.
 - 5. Electronic components, except primary surge protection and voltage adjusting resistors, shall be mounted on plug-in circuit cards or plug coupled subassemblies to facilitate testing and maintenance.
- C. Safety
 - 1. Vital microprocessor-based units shall be designed using the closed loop principle to achieve safety.
 - 2. Vital microprocessor-based units, especially with respect to outputs, shall react in a safe manner to all failure modes. The unit shall not continue system control if it fails to pass system integrity tests.
 - 3. Design shall be complete with all necessary lightning and surge protection for the equipment itself, the input and outputs, and the system as a whole. The design shall be entirely adequate for the electrical and environmental environment and the equipment being operated.
 - 4. All application specific logic in any signal related equipment shall be capable of modification by Administration personnel. The Contractor shall provide source codes and other utilities required to make both vital and non-vital modifications to the application software. The Contractor shall also furnish a “re-testing tool” designed to minimized the re-testing of application logic after a change has been made to the software.

- a. Application software shall be password protected. It shall not be possible to make changes to the application software without having the user selectable password.
 - b. All vital firmware must have complete identification on each individual ROM or other storage devices to prevent the application of the programming to the wrong location. The application logic shall include a keying system such that even if the program for another location is inadvertently installed in a microprocessor it shall not operate and shall alert the user as to the error.
5. Hardware whose failure modes may adversely affect the safe implementation of a vital function but which is not designed as vital hardware shall be considered vital. Failure modes in this hardware shall be revealed or otherwise accounted for by means other than vital hardware design techniques. These means include, but are not limited to, software checking and comparison of independent hardware circuits.
 6. Equip with onboard diagnostics to detect failed printed circuit boards or other hardware, as specified herein. The operation of any diagnostics that may change software routines or otherwise compromise safety shall be accessible through a hardware or software security system designed to warn the user that a dangerous situation may be created.
 7. Divide the operating instructions for the vital microprocessor into executive and application dependant portions. The use of electrically erasable programmable ROM (e.g., flash memory) is acceptable.
 - a. Store the executive instructions in solid state read only memory (ROM) or solid state programmable read only memory (PROM) devices and as the Executive Firmware.
 - b. Store the application dependant instructions in solid state PROM devices and designate as the Application Dependant Firmware.
 8. Refer to Section 01 43 00 –Systems Quality Assurance, for additional safety and reliability requirements.
- D. Serial Links
1. Serial communications between processors implementing vital functions shall be vital. Security protocol, including handshaking and error detection, shall be used to ensure the validity of data. Data shall default to the most restrictive state unless a valid transmission is received. Serially transmitted data between subsystems shall be repeatedly updated to ensure the integrity of the communications link.
- E. Documentation
1. Provide a complete and detailed hard copy print out, and an electronic copy, of all vital and non-vital software for each location in accordance with the requirements of Section 01 33 00 – Submittal Procedures. The programs shall be modularized in a logical and easily understood manner. Each module shall be fully annotated, including revision blocks with plain English explanations of the function of each module and the methods and means it uses to accomplish its tasks. Include for all related modules required to take part in the execution of the instructions.
 2. Identify all data passed from one vital controller to another vital controller and all data passed from any vital controller to the non-vital controller, local control processor, as well as hardwire interfaces. Identify all terms in the Boolean or ladder expressions and all data received by or sent from the controllers with standard relay logic nomenclature. Translation tables will not be accepted.

- F. Timers: Provisions shall be made in the design to adjust all functions requiring adjustable timers (e.g., ASR timers) without changing program software. Install timers external to the processors if necessary. External timers shall meet the requirements of Section 34 42 25 Relays and Plugboards.

2.2 VITAL INTERLOCKING MICROPROCESSOR

- A. General: The vital microprocessor-based unit shall be "fail-safe" in all modes of operation and shall meet the Product Requirements of Section 01 XX 00. The microprocessor shall:
1. Operate according to AREMA C&S Manual, Part 2.2.12 – Recommended Functional/Operating Guidelines for Vital Software-Based Interlocking Systems.
 2. Provide all controls, indications, safety checks, and all other functions required for the signal system. The processor shall be capable of receiving signal, switch, and route requests from the LCP and the TWC System.
- B. Connections: Connections to external non-electronic vital signal apparatus shall be on compression-type terminals or other solderless connectors, as approved by the Resident Engineer.
- C. Inputs/Outputs (I/O)
1. The microprocessor system shall provide for vital and non-vital inputs. A visual indication, such as a light emitting diode (LED), shall be provided for each input on the input board. It shall illuminate continuously when the input is activated. Vital inputs for the equipment shall have an option to selectively debounce each input. Vital inputs shall be electrically and physically vitally isolated from each other.
 2. The microprocessor shall provide vital and non-vital outputs. A visual indication, such as an LED, shall be provided for each output on the output board. It shall illuminate continuously without use of a pushbutton when the output is activated. Vital outputs shall be electrically and physically isolated from the logic power supply. If output is used to drive double break circuitry, the output shall be physically and electrically isolated from each other.
 3. Inputs shall be buffered and shall be immune to contact bouncing and shall be electrically and physically isolated from one another in accordance with AREMA recommended practice for vital circuits. Access to inputs must be unique in the sense that under failure, reading of the incorrect input circuit will not result in a falsely permissive input being utilized in vital processing.
 4. A label shall be provided for each input and output indication which denotes the respective function of each to facilitate troubleshooting and maintenance.
 5. A falsely permissive non-vital input shall not adversely affect the safety of the vital function processing.
 6. Outputs shall be electrically and physically isolated from one another in accordance with AREMA recommended practice for vital circuits. Single break type outputs may have a common reference. . The executive software shall constantly check to verify that all outputs are in the state requested by the application software. Access to the outputs shall be unique in the sense that under failure, writing to the wrong output circuit will not result in a falsely permissive output being generated. Processor communication with each output shall vitally assure that the proper output is in the proper state (on or off).

7. The vital processor shall assure correspondence of each vital output between the actual and requested states. No output shall remain active when requested inactive. Means shall be provided to assure the capability to remove all energy from a failed vital output. Wherever possible, the system should be fault-tolerant such that single output failures do not force a system shutdown, unless the state of a vital output is potentially unknown.
- D. Internal Diagnostics: The processor subsystem shall incorporate vital self-checking tests to ensure the equipment and program is functioning as intended. The checks shall be integral parts of both hardware and software to provide for a secure system.
1. The vital processor shall not allow false information to persist long enough to allow an unsafe condition to occur, or allow false information to be transmitted to external devices which will create a hazardous condition. Processor shall use a vital "kill" relay circuit to de-energize all outputs in the event of a safety related I/O or processor failure. In the event that the "kill" relay becomes de-energized, signals shall be lit red rather than being dark. The "kill" circuit shall de-energize all outputs in a time less than the fastest activation time of any external device connected to a vital output. The kill circuit shall use vital circuit design techniques to assure that no false signal that could be generated by any other device in the relay case (e.g., power supplies, audio or coded equipment), or harmonics of these devices shall energize the output power relay.
 2. Provide visual indicators, such as LEDs, to demonstrate that the system is functioning as intended; similarly provide failure and diagnostic indications. Indicators shall isolate a failure to a particular function, or the interface between two functions.
 3. Transmission of false information from a non-vital to a vital subsystem shall not affect the safety of the vital subsystem.
 4. System outputs shall be positively monitored with independent current/voltage sensors and compared to the requested value. The "kill" circuit shall de-energize all outputs and shutdown the system when the outputs fail to correspond to the required state or a more restrictive state. Diagnostic checks shall act on current (fresh) data only. Memory locations used to determine the proper states of inputs and outputs shall be cleared or overwritten prior to being reused during each cycle of tests to ensure the integrity of the check. The diagnostic checks shall be independent of the application logic for the system. The system shall attempt an automatic restart after executing safety checks.
 5. Diagnostics shall check to assure synchronized tasks shall execute correctly in the proper order. Checks shall shutdown the system in the event the processor is overloaded.
 6. PROMs and erasable programmable read only memory (EPROMs) shall be checked, as part of program execution, during each cycle, to ensure they have been unaltered during processor execution. Benchmarks shall be created for blocks of memory to implement these tests.
- E. Access: A method of security shall be provided to allow only authorized user access. The system shall not interfere with operation of the wayside vital processor system. Access shall be through the use of the laptop computers provided in this Contract. Refer to Section 34 42 72 – Spare Parts, Manuals, and Training for additional requirements.

- F. Trouble-Shooting: The microprocessor system shall be capable of interconnection to the portable laptops, provided in this Contract, to permit interrogation (via keyboard/keypad) and observation (via monitor/display) of internal logic bits during testing and normal operations. This interface shall use English-Text and Arabic numeral nomenclature with explanation of faults in easy to read text. Operator interface shall be via menu driven commands with an on-line HELP feature to describe use of commands.
- G. Noise: The microprocessor system shall be designed to operate in the presence of the following noise sources:
1. Lightning surges and voltage surges from external power distribution systems;
 2. Transients from nearby power lines, propulsion return currents, back electricmagnetic field (EMF) from operating relay coils, arcing contacts, radio frequency (RF) noise such as hand-held radios and;
 3. I/O wiring from the I/O card file to external terminal strips.
- H. Site Specific Firmware: Provide site specific application dependent firmware for each location that meets the operational requirements Section 34 42 68 – Signals Circuit and Operational Requirements, and the Contract Drawing Route and Aspect Charts.
- I. Support Equipment: Provide tools and test equipment in accordance with the requirements of Section 34 42 72 – Signals Spare Parts, Manuals, and Training.

2.3 MICROPROCESSOR TEST SET

- A. The Contractor shall supply a “test set” for the vital microprocessor. The intent of this requirement is to provide the signal maintainers with a known good unit into which they can substitute suspect PCB’s from other vital microprocessor units to determine if they are in fact good or bad. The test set shall:
1. Be completely contained in a portable “half rack” so that no assembly or disassembly is required to move it. This “half rack” shall be mounted on lockable wheels so as to make it easily transportable.
 2. Have all of the wiring contained within the half rack so that the only required connection is to plug the unit into a standard 110VAC power outlet (wall plug).
 3. Have a self-contained power supply to convert the 110VAC to the required system operating voltage.
 4. Contain at least one of every type of PCB (both vital and non-vital) that is used at the interlockings controlled by a vital microprocessor.
 5. Be programmed so that all of the boards in the test set are functioning completely. This means that:
 - a. All serial ports are defined and working.
 - b. All parallel I/O points are defined and working.
 - c. All parallel I/O points are changeable and the results are observable. For example, output one may be mapped to input one such that when the input is changed the corresponding output also changes and is observable.
 6. Provide a means to toggle each input point.
 7. Provide a means to see that each output is changing state as requested.

8. Provide all of the diagnostics that would be available if this were a working unit in the field.
- B. The proposed design of the test set shall be forwarded to the VMR prior to manufacture for approval.
- C. Provide a similar test set for the solid state highway crossing controller.

2.4 EVENT RECORDERS

A. General

1. Provide an event recorder in all cases to record controls, indications, and internal variables. An event recorder is not required in a relay case if the vital microprocessor-based equipment provided can store the same information under the same conditions, as specified herein. In addition to recording the controls and indications sent via the TWC system or the local control panel, record all vital functions as necessary for AGENCY to accurately re-create an event. Provide AGENCY a complete list of proposed functions to be recorded with the product submittal. Such functions shall include;
 - a. Approaching locking
 - b. Time locking
 - c. Switch locking
 - d. Route locking
 - e. Route check
 - f. Signal clear
 - g. Directional sticks
 - h. Switch position
 - i. Track circuit occupancy
2. Provide sufficient memory to store a minimum of 7 days worth of normal operations monitoring without the loss of any data (e.g., without the necessity to overwrite the first recorded occurrence of the 7 day period).
3. Provide a unit that is capable of generating alarm status based on user definable conditions.
4. Provide a unit that is capable of being configured, monitored, and tested by the laptop computers provided in this Contract, connected locally. The unit shall be Windows-based, and shall, to the maximum extent practicable, be user friendly.
5. The unit shall record all functions in plain English, at the time the event actually occurred. Event logs shall be readable without requiring numeric to alphanumeric conversion.
6. Provide accurate and reliable sequence of event reporting in the playback mode.

PART 3 - EXECUTION**3.1 INSTALLATION**

A. General

1. Provide all units complete with mounting hardware, power supply, cables, connectors, and all other miscellaneous equipment and material required for configuration, operation, and testing.
2. Mount all equipment, including associated power supply and support equipment, in the wayside signal building or case.
3. Install microprocessor equipment per the recommendations of AREMA C&S Manual, Part 1.5.1 Recommended Instructions for the Installation and Maintenance of Solid state Equipment.
4. Before proceeding with any software upgrade, employ electrostatic discharge precautions to ensure that PROM internal circuits are not accidentally damaged by high static voltages or electrostatic fields. Such precautions shall include, but not be limited to:
 - a. Removal, old PROMs shall be inserted into conductive foam material.
 - b. Except when necessary, avoid touching the PROM leads.
 - c. Use integrated circuit extractor/insertor tools designed to remove and install electrostatic PROMs.
 - d. When replacing PROMs, always lay the module on the electrostatic bag provided by the manufacturer, not on the work surface.

B. Following Noise Mitigation: Suppress or prevent noise from entering into the system using the following practices:

1. Use lightning arrestors and secondary surge suppressers to protect against lightning and other voltage surges, in accordance with AREMA C&S Manual, Part 11.2.1 Recommended General Practices for Electrical Surge Protection of Signal Systems.
2. Ground all card files, modems and other system components to the cabinet ground stud to earth ground through a capacitor to establish ground.
3. Connect shields on serial communication cables to earth ground on one end only.
4. Provide required load to unused outputs.
5. Ensure proper pickup and dropaway relay currents per relay specifications when interfacing relays to I/O cardfiles.
6. Install standard suppression on all relay coils.
7. Use twisted pair wires for all inputs.
8. Shorten wire harnesses from I/O cardfiles to external terminal strips and dress these wires away from the central processing unit (CPU).
9. "Oversize" power supplies and design associated power busses to minimize noise produced by voltage drop of transient currents. External filtering may be used to reduce transient current noise on the power bus.

10. Separate connections to external apparatus from internal wiring carrying processor signals.
 11. Keep cabling between cardfiles as short as possible to minimize induced noise and group microprocessor-based system racks together, although sufficient slack shall be provided for a service loop.
 12. Mitigate the effects of noise, transients and grounds that appear on inputs and outputs to the system. Cable conductors and track mounted devices are regularly exposed to water and traction power induced transients. System instability, processor rest or processor shutdown shall not be a normal response to these input and output conditions.
 13. Power wires or wires that could have transient currents and that run in the racks shall be isolated to running on one side of the rack away from any I/O card files.
- C. Maintenance: To facilitate maintenance, diagnostics shall be organized such that detectable failures will energize LED indicators mounted on the edge of either the individual PC cards, or on a centralized board, which will allow a technician to determine system operating status and errors. A method of security shall be provided to allow only authorized user access. The security system shall not interfere with operation of the vital microprocessor subsystem.
- D. Test: Test microprocessor-based systems in accordance with the requirements of Section 34 42 76– Signals Tests and Inspections.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

- A. The quantities of accepted work will be measured in the following units. All measurements will be plan measure except for authorized changes.
1. Description: Lump Sum

4.2 PAYMENT

- A. Payment will be made at the respective unit or lump-sum price listed in the proposal and shall be full compensation for all labor, materials, and equipment necessary to complete the respective unit in place. There will be no separate measurement or payment for any item of work not specifically identified and listed in the proposal, and all such work shall be considered a subsidiary item with all costs pertaining thereto included in the prices for other items listed in the proposal. At the Engineer's option, partial payment may be made for any lump sum item listed in the proposal, providing that the Contractor is diligently and satisfactorily pursuing full completion of such partially complete item in accordance with the approved job progress schedule.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 34 42 25**SIGNALS RELAYS AND PLUGBOARDS****PART 1 - GENERAL****1.1 SUMMARY**

- A. This Section includes the requirements for furnishing and installing vital and non-vital signal relays. All signal logic shall be generated by microprocessor-based systems. The use of relays shall be minimized to the maximum extent possible. The Contractor is encouraged to submit any functions such as light out protection or switch control that are normally handled by special purpose relays that can be included as an integral part of the microprocessor system to the Agency Representative for approval. Where Relays are required for specific applications, they shall meet the following requirements:

1.2 RELATED SECTIONS

- A. SECTION 01 33 00 – Submittal Procedures
- B. SECTION 01 43 00 – Systems Quality Assurance
- C. SECTION 34 42 10 – Signals General Engineering and Design Requirements
- D. SECTION 34 42 68 – Signals Circuits and Operational Requirements
- E. SECTION 34 42 76 – Signals Tests and Inspections

1.3 REFERENCES

- A. American Railway Engineering and Maintenance-of-Way Association, Communications & Signals Manual of Recommended Practice [AREMA C&S Manual]
1. AREMA C&S MANUAL, PART 6.1.20 – Recommended Design Criteria for Time Element Relay, Tractive Armature or Electronically Controlled Type.
 2. AREMA C&S MANUAL, PART 6.2.1 – Recommended Design Criteria for Tractive-Armature Direct-Current Neutral Relay (Plug-In Type).
 3. AREMA C&S MANUAL, PART 6.2.2 – Recommended Design Criteria for Vital Plug-in Relay Plugboards.
 4. AREMA C&S MANUAL, PART 6.3.1 – Recommended Design Criteria for Neutral Direct-Current Relay for Non-Vital Circuits.
 5. AREMA C&S MANUAL, PART 6.4.1 – Recommended Instructions for Direct Current Relays.
 6. AREMA C&S MANUAL, PART 6.5.1 – Identical Items “Boilerplate” for all Relay Manual Parts in Section 6.

1.4 QUALITY ASSURANCE

- A. The Contractor shall comply with the requirements of Division 1

1.5 SUBMITTALS

- A. Unless otherwise specified, all submittals shall be in accordance with SECTION – 01 33 00 - Submittal Procedures and SECTION 34 42 10 – Signals General Engineering And Design Requirements.
- B. Vital Relay Product Data: Submit catalogue cuts and technical data including fully dimensioned layouts, in plan and elevation, showing arrangement of components and all pertinent data for each type of vital relay, including timers, proposed for use. Include suppression details and plugboards.
- C. AREMA Office Records Test Form: Submit an applicable AREMA Office Records Test Form for each vital relay furnished as a part of this contract. Type in all information required on the form and field verify.
- D. Non-Vital Relay Product Data: Submit catalogue cuts and technical data for each type of non-vital relay and plugboard proposed.

PART 2 - PRODUCTS

2.1 VITAL LOGIC RELAYS

- A. General: Provide Safetran plug-in type relays, Alstom Signaling plug-in type relays, Union Switch and Signal (an Ansaldo affiliated company) "PN" series, or "owner approved equal," meeting the requirements of AREMA C&S Manual Part 6.2
 - 1. Relays of each type shall be uniform in design and contact assembly.
 - 2. Provide relays complete with relay unit, plug base, crimp type two wire terminals, base and relay tags, all mounting hardware, identification and keying plates and accessories necessary to complete the installation.
 - 3. Facilities shall be provided on the front of the plug board for testing current.
 - 4. Provide a means, built into the relay cover, for mounting a typed or printed relay name tag on the front of each relay. The name tag shall be easily replaceable, but shall not come off during normal service. The relay plugboard shall also be supplied with a name tag, on both the front and the back.
- B. Contacts
 - 1. With the exception of special function relays (i.e., overload relays), provide each relay with either six dependent front-back contacts or four dependent front-back contacts, two front contacts, and one back contact.
 - 2. Provide front contacts of silver-to-silver impregnated carbon and make all back contacts silver-to-silver. Contacts shall meet the requirements of the AREMA C&S Manual, Section 6.5.1.
 - 3. Design the relay contacts so that when cycled 5,000,000 times while interrupting and making a current of 0.25 A at 12 V to 16 V, the contact resistance shall not exceed 0.5 Ω .
- C. Interchangeability: Provide identical relays for all signal logic functions, except special function relays.

- D. Biased Neutral
 - 1. Design so that their armature will not pick up with the permanent magnet demagnetized.
 - 2. Design so that their armature will not pick up when coils fail to receive current due to an interruption of the normal magnetic circuit.
 - 3. Design so that up to at least 50 times working energization voltage applied for 2 seconds at both normal and reverse polarity will not affect their operating characteristics by more than 2 percent, and will not pick up their armature on reverse polarity.

2.2 VITAL SWITCH CONTROL RELAYS

- A. General: Provide vital switch control relays, external to the microprocessor-based system, as specified, meeting the requirements for vital DC relays except as modified herein.
- B. Switch Operating Relays
 - 1. Provide a minimum of two independent front contacts and two independent back contacts.
 - 2. Equip each contact with a magnetic blow-out feature to extinguish electrical arcs caused by the interruption of high currents and to minimize contact wear.
 - 3. Each contact shall be capable of interrupting the normal switch-and-lock movement current 10,000 times without its resistance exceeding 1.0 Ω measured at 5 A.
 - 4. The relay shall be from the same manufacturer as the switch machine. If the contractor wants to use a different manufacturer for the relay, then the contractor shall submit for approval the technical details of the switch machine and relay illustrating sufficient contact rating of the relays for the application.
- C. Switch Overload Relays: Provide relays to detect an overcurrent condition during operation of power switch machines, meeting the following requirements:
 - 1. Equip relays with two separately wired, non-biased coils: one coil series-connected in the switch operating circuit to detect overcurrent conditions, and the other coil used as a holding coil in the overload stick circuit.
 - 2. Furnish relays with a sufficient number of make-before-break contacts to perform functions specified herein.
- D. Flasher Relays: Provide electronically-driven flasher relays to control flashing aspects for crossing warning systems, if required.
 - 1. Equip relay with a minimum of four dependent front-back, heavy duty, non-fusing lamp control contacts of silver cadmium oxide.
 - 2. Contacts shall maintain full back contact pressure while the relay is not operating.
 - 3. Flasher shall operate from the 12 VDC power supply available in the building or case.
 - 4. Flasher shall maintain a constant ratio of "on-off" time of 56 to 64 flashes per minute throughout the system variations in voltage and temperature.

2.3 VITAL DC TIMER RELAYS

A. General

1. Vital DC timer relays shall be solid-state. Provide each vital DC timer relay with a minimum of two independent timing contacts, which provide an equivalent of a front-back contact.
2. Vital DC timer relays shall be in accordance with AREMA C&S Manual, Part 6.1.20, except as otherwise specified.

B. Adjustment: Equip timers with a sealable timing interval adjustment, to meet design requirements, in increments of 1 sec or less.

1. When adjustment is sealed, it shall not be possible to adjust the timing interval without breaking the seal.
2. Once adjusted, the timing interval shall be repeatable with an error of no more than +/- 5 percent under specified variations in operating voltage and ambient conditions.

2.4 VITAL AC VANE RELAYS

A. General

1. Provide plug-in two-element, 60 Hz, induction relays.
2. Relays shall conform to AREMA C&S Manual, Part 6.1.35 and Part 6.2.1.
3. Provide a minimum of two dependent front-back contacts.

B. Voltage: Relays shall operate continuously without damage with a minimum voltage range of 100 to 135 V AC applied to the local winding, and with a minimum voltage range of 0.75 to 5 V AC applied to the control winding.

2.5 VITAL RELAY PLUGBOARDS

A. General

1. Provide a rack-mounted type plugboard for each vital relay.
2. Plugboards shall be in accordance with the applicable sections of AREMA C&S Manual, Part 6.2.2.
3. The fastening of relay to plugboard shall hold the relay securely in place and facilitate removal.
4. Plugboards shall facilitate voltage testing.

B. Contacts

1. Design plugboards for insertion of removable-type connectors. Attach wires to the removable connectors by a solderless crimped connection. Fast-ons or other non-insert connectors are not acceptable.
2. Design vital relay plugboards so that the removable connectors will have a direct connection with the relay coil and with the contact prongs.
3. Contacting members to carry current between relay and plugboard shall be in constant contact, and the contact resistance shall not exceed 0.03 Ω .

- C. Identification: Plugboard shall have a tag, on both front and back, unless approved otherwise, to indicate the nomenclature of the relay for which it is wired. Provide relay contact identification on the plugboard.
- D. Registration: Equip vital relay plugboards with a registration plate to prevent relays of wrong style, contact arrangement, or operating characteristics from being inserted.

2.6 NON-VITAL RELAYS

- A. General: Provide non-vital relays in accordance with the requirements of AREMA C&S Manual, Part 6.3.1.

2.7 NON-VITAL RELAY PLUGBOARDS

- A. General
 - 1. Provide a rack-mounted type plugboard for each relay or pair of relays.
 - 2. The fastening of relay to plugboard shall hold the relay securely in place and facilitate removal.
- B. Contacts: Design plugboards for insertion of removable-type connectors. Attach wires to the removable connectors by a solder-less crimped connection. Fast-ons or other non-insert connectors are not acceptable.
- C. Identification: Plugboard shall have a tag, on both front and back, unless approved otherwise, to indicate the nomenclature of the relay for which it is wired. Provide relay contact identification on the plugboard.

PART 3 - EXECUTION

3.1 APPLICATION

- A. General: Refer to SECTION 34 42 68 – Signals Circuits And Operational Requirements, for requirements.
- B. Timers: Provisions shall be made in the design to adjust all functions requiring adjustable timers (e.g, ASR timers) without changing program software. Install timers external to the processors if necessary.

3.2 INSTALLATION

- A. General
 - 1. Ensure that all power buses are open while installing relays. Do not reconnect these buses until all relays have been installed and power and ring out tests have been performed.
 - 2. Keep all relays covered at all times except while tests or approved modifications involving those relays are in progress.
- B. Vital Relays: Install all relays in plugboards on racks. In cases, install on mounting hardware specifically designed for relays.
- C. Shipping: After completion of factory test, remove relays from racks and cases and pack separately.
- D. Test: Test relays in accordance with the requirements of SECTION 34 42 76 – Signals Tests And Inspections

PART 4 - MEASUREMENT AND PAYMENT**4.1 MEASUREMENT**

A. The quantities of accepted work will be measured in the following units. All measurements will be plan measure except for authorized changes.

1. Description: Lump Sum

4.2 PAYMENT

A. Payment will be made at the respective unit or lump-sum price listed in the proposal and shall be full compensation for all labor, materials, and equipment necessary to complete the respective unit in place. There will be no separate measurement or payment for any item of work not specifically identified and listed in the proposal, and all such work shall be considered a subsidiary item with all costs pertaining thereto included in the prices for other items listed in the proposal. At the Engineer's option, partial payment may be made for any lump sum item listed in the proposal, providing that the Contractor is diligently and satisfactorily pursuing full completion of such partially complete item in accordance with the approved job progress schedule.

END OF SECTION

SECTION 34 42 29**SIGNALS ELECTRICAL AND ELECTRONIC COMPONENTS****PART 1 - GENERAL****1.1 SUMMARY**

- A. This Section includes Specifications for electrical and electronic components.

1.2 RELATED SECTIONS

- A. SECTION 01 33 00 – Submittal Procedures
- B. SECTION 01 43 00 – Systems Quality Assurance
- C. SECTION 34 42 10 – Signals General Engineering and Design Requirements
- D. SECTION 34 42 44 – Signals Power Distribution
- E. SECTION 34 42 76 – Signals Tests and Inspections

1.3 SUBMITTALS

- A. Unless otherwise specified, all submittals shall be in accordance with SECTION 01 33 00 – Submittal Procedures and SECTION 34 42 10 – Signals General Engineering And Design Requirements.
1. The Contractor shall submit manufacturer's specifications, product literature and shop drawings for the following:
- a. Power supplies
 - b. Transformers
 - c. Printed circuit cards
 - d. Integrated circuits
 - e. Characteristics of all semiconductors, resistors, reactors, capacitors, inductors and fuses
 - f. Printed circuit card connectors
 - g. Electronic data processing equipment (including microprocessors and event recorders)
- B. The Contractor shall submit detailed product information, including hardware and software specifications, functional descriptions, block diagrams and flow charts for all electronic data processing hardware and software. Software listings shall be submitted which accurately and completely characterize the operating and application programs in use and fully describe the means to reprogram such equipment at the user level.
- C. The Contractor shall submit as-built drawings for all components and equipment to provide accurate and complete documentation of the in-service configuration and status.

1.4 QUALITY ASSURANCE

- A. The Contractor shall comply with requirements of Division 1
- B. The Contractor shall factory test all electrical and electronic components prior to installation in accordance with manufacturer's test procedures and provisions of SECTION 34 42 76 – Signals Tests And Inspections.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Electrical and electronic components shall be:
 - 1. New and free of manufacturing defects
 - 2. Free of storage and handling damage
 - 3. Clearly and permanently labeled with values or type identification
 - 4. Rated to operate at levels exceeding by at least 25%, those operating parameters such as power, voltage, current and temperature, which the component will be subject to in normal service, except as otherwise specified, or as Approved by the Agency.
 - 5. Commercially identified and available in the Kansas City area
 - 6. Capable of operating in the environment specified

2.2 SEMICONDUCTORS

- A. Semiconductors shall be silicon type with Joint Electron Device Engineering Council (JEDEC) numbers, except as otherwise specified, or as Approved by the Agency.
 - 1. Zener diodes used for voltage regulation or reference levels shall not be damaged if the entire load is removed and shall have a zener voltage tolerance of plus or minus 5% maximum. Zener diodes used for transient protection shall not be damaged in performing their function under all actual conditions encountered in the operating system.
 - 2. The use of integrated circuits shall be such that manufacturer's ratings are not exceeded under normal operation. Integrated circuits shall be protected against over-voltage and noise in the designed installation.
 - 3. Optically coupled isolators using gallium arsenide emitters and gallium arsenide phosphide light-emitting diodes will be permitted. Manufacturer's ratings shall not be exceeded under normal operation.

2.3 ELECTRICAL DEVICES FOR USE WITH ELECTRONIC COMPONENTS

- A. Resistors
 - 1. Resistors shall have a maximum tolerance of plus or minus 5% and shall be rated to dissipate a minimum of 1.5 times the maximum operating power.

- B. Capacitors
1. Capacitors 10 microfarads or less in value used in electronic modules shall have a maximum tolerance of plus or minus 10% and shall be rated for at least 1.5 times the maximum operating peak voltage.
 2. All other capacitors shall have a maximum tolerance of -50% to +75% and shall be rated for at least 1.5 times the maximum peak operating voltage.
- C. Inductors
1. All inductors used in electronic modules shall have impregnated windings and shall withstand twice the maximum peak-to-peak voltage they will be subjected to in operation.
- D. Transformers
1. All power transformers used in electronic modules shall have:
 - a. Minimum inter-winding breakdown voltage of 1000 VDC
 - b. No emitted audible noise in excess of 40dB referenced to 0.0002 dynes/square centimeter at a distance of 2 feet while operating at rated voltage and load
 - c. Impregnated windings
- E. Printed Circuit Cards
1. Shall be of NEMA G-10 epoxy glass laminate construction.
 2. Shall have thickness sufficient to permit easy insertion and removal.
 3. Shall have circuits formed by etching.
 4. Conductor material shall be copper and protected from exposure to air.
 5. Shall be marked with identification for each component adjacent to the place where it is to be installed.
 6. The Contractor shall provide diagrams illustrating the layout and identification of each component on the printed circuit card as Approved by the Agency.
- F. Printed Circuit Card Connectors
1. Printed circuit card connectors and associated terminals shall be:
 - a. Etched on both sides of the printed circuit card connections
 - b. Gold plated 0.000025-inch minimum
 - c. Insulation resistance greater than 1000 Megohms at 500 VDC
 - d. Temperature rating of -55 degrees Celsius to +105 degrees Celsius
 - e. Connector shall withstand card removal/insertion for regular maintenance
 - f. Keyed to accept only those cards intended for that particular position, unless an electrical keying scheme is employed.

2.4 ELECTRICAL DEVICES FOR OTHER APPLICATIONS

- A. Power Transformers shall be as referred to in SECTION 34 42 44 – Signals Power Distribution.
- B. DC power supplies, except as otherwise specified, shall meet the following specifications:
1. Input Voltage – 120 VAC \pm 10%, 100 Hz or 60 Hz as required
 2. Regulated output voltage – nominal DC voltage \pm 5%, adjustable to \pm 50%
 3. Output current – 50% over normal load
 4. Overload protection
 5. Reverse current protection
 6. Equipped with power off detection. The power off detection of each of the power supplies shall be gathered together to operate the “DC Power Off” light on the local control panel.
 7. Clearly and permanently labeled with the rating or type, identification and function
 8. Sufficiently filtered to ensure that rated output voltage will be maintained for power interruptions of less than 65 milliseconds at rated load
 9. Adjustable over-voltage protection that disables the output when the trip level is exceeded
 10. Ripple shall be less than 100 millivolts RMS or 1% of the output voltage. Ripple maximums shall be compatible with the solid state equipment supplied by the Contractor.
 11. Power supply shall be mounted in perforated enclosures.
 12. Power supply front panel shall contain at a minimum, an output ammeter, and an output voltmeter (this may be one meter with selector switch). Meter accuracy shall be \pm 2%.
- C. Fuses
1. Shall be the non-renewable, of fiber-case, time-lag, fusion, indicating type
 2. Shall be the correct size and rating to protect electrical equipment from overload
 3. In DC circuits, a protective unit shall be provided
 4. Shall be centrally located on the power distribution panels and power racks

2.5 CIRCUIT INTERRUPTERS (BREAKERS)

- A. Equipment intended to break current at fault levels shall have interrupting rating sufficient for the system voltage and the current which is available at the line terminals of the equipment. Equipment intended to break current at other than fault levels shall have an interrupting rating at system voltage sufficient for the current that must be interrupted.

PART 3 - EXECUTION

Not Used

PART 4 - MEASUREMENT AND PAYMENT**4.1 MEASUREMENT**

A. The quantities of accepted work will be measured in the following units. All measurements will be plan measure except for authorized changes.

1. Description: Lump Sum

4.2 PAYMENT

A. Payment will be made at the respective unit or lump-sum price listed in the proposal and shall be full compensation for all labor, materials, and equipment necessary to complete the respective unit in place. There will be no separate measurement or payment for any item of work not specifically identified and listed in the proposal, and all such work shall be considered a subsidiary item with all costs pertaining thereto included in the prices for other items listed in the proposal. At the Engineer's option, partial payment may be made for any lump sum item listed in the proposal, providing that the Contractor is diligently and satisfactorily pursuing full completion of such partially complete item in accordance with the approved job progress schedule.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 34 42 33**SIGNALS PRE-FABRICATED RELAY CASES****PART 1 - GENERAL****1.1 SUMMARY**

- A. Section Includes:
 - 1. Furnish and install factory wired relay cases as described herein and as shown in the Contract Drawings.
 - 2. Provide relay cases adequate to house all equipment and provide spare space as described in these Specifications.
 - 3. Furnish AC Power as necessary.

1.2 RELATED SECTIONS

- A. SECTION 01 33 00 – Submittal Procedures
- B. SECTION 01 43 00 – Systems Quality Assurance
- C. SECTION 34 42 10 – Signals General Engineering And Design Requirements

1.3 SUBMITTALS

- A. Unless otherwise specified, all submittals shall be in accordance with SECTION 01 33 00 – Submittal Procedures and SECTION 34 42 10 – Signals General Engineering And Design Requirements.
 - 1. A listing of each relay case to be used with its location and proposed size shall be submitted within 14 days of NTP. This information will be used to real estate allocations.
 - 2. Description and/or catalog cut of the proposed relay cases furnished including the proven equipment history.
 - 3. Drawings showing the proposed size, equipment layout, and the method of mounting the required local control panel, vital microprocessor, event recorders, communication interface equipment, and construction of each relay case.
 - 4. Factory test procedure.
- B. Drawings showing the concrete foundations to be used and the ground grid to be installed.
- C. Details of relay case power distribution plan.

1.4 QUALITY ASSURANCE

- A. The Contractor shall comply with the requirements of Division 1.

PART 2 - PRODUCTS**2.1 SIGNAL CASES**

- A. Signal cases shall be constructed from powder-coated, galvanized steel.
- B. Free-standing signal cases, whether or not they house signal instruments, shall be constructed from 12 gauge (minimum) sheet steel on the top, bottom, and all sides.
- C. Signal cases shall be furnished with 1 inch (minimum) of Thermax® insulation on the walls and top.
- D. Signal cases shall also be furnished with backboards and battery boards.
- E. Equipment carrying more than 150V shall be separated and segregated from all other equipment in that same signal case.
- F. Conductors carrying more than 150V shall be in conduit inside of any signal case.
- G. Equipment carrying more than 150V shall be enclosed in a separate metal enclosure inside of any signal case.
- H. Each signal case that contains any signal equipment, other than cases used only for the termination of cables, shall be provided with fluorescent lighting and two 117 Vac duplex convenience outlets.
- I. Design and Fabrication:
 - 1. Doors:
 - a. Hinge and gasket the exterior doors (three minimum) so that they will provide a dust proof and weatherproof seal. Gasket material shall meet requirements of AREMA Communications and Signals Manual, Part 15.2.10 (Recommended Functional Guidelines for Gasket Material Suitable for Circuit Controllers, Signal Cases and Other Signal Apparatus Housings).
 - b. Provide one or two doors that are used to access the rear end of the main terminal board (entrance rack).
 - c. Design doors with a two-position latching device which shall prevent them from being struck by passing trains when open.
 - d. Provide doors with handles, hasps, and a three-point locking device which will ensure door cannot be locked when it is not fully closed.
 - e. Each door shall contain ventilating openings in accordance with the manufacturer's standards. Louvers shall be closeable, covered with fine stainless steel mesh screens, dust filters and protected by weather caps, which shall prevent the entrance of moisture.
 - f. Hinges shall be separate castings securely fastened to the housing and door. Equip the hinges with bronze hinge pins and pressure lubricating fittings. Lubricate hinges before the case is shipped.
 - 2. Relay cases shall be sized to easily accommodate all of the required equipment plus at least 10% usable continuous spare space. If necessary to use more than 1 relay case interconnecting wires shall be pipe connected.

3. Prior to purchase and fabrication equipment layouts within the case shall be as submitted for approval to ensure ease of maintenance and that spare space requirements have been met.
4. The relay case shall be dust tight and insulated to provide maximum heating system efficiency.

2.2 CASE FACILITIES

A. AC Power

1. All relay cases shall be furnished complete with utility connection, meter, circuit protective devices and all appurtenances necessary to supply the AC power required at each site.
2. The Contractor shall be responsible to obtain power for all relay cases. This includes obtaining all required permits.
3. All relay cases shall be provided with a main entrance circuit breaker as a part of the load center. In addition, power inputs to the following signal equipment shall be provided with fuses or circuit breakers:
 - a. Duplex Outlets
 - b. Switch Machines
 - c. Switch indicators/Signals (each signal)
 - d. Power Frequency Track Circuits
 - e. Battery Chargers
 - f. Local Control Panel
 - g. Power Supplies/Rectifiers

B. Contractor shall coordinate division of work between factory installed wiring and field run wiring.

C. Lighting/Outlets:

1. Provide fluorescent lighting at the top of the case.
2. Control the lights by a switch located immediately adjacent to one of the relay case front doors.
3. All convenience outlets installed in relay cases shall be duplex, 120VAC Ground Fault Circuit Interrupter (GFCI) outlets.
4. Each relay case shall be equipped with one convenience outlet adjacent to each front door. All outlets shall be protected by circuit breakers with a minimum rating of 15 amps
5. Power calculations shall assume a constant total draw of 6 amps.

D. Lightning and Transient Protection

1. All relay cases shall be designed, fabricated, and installed in accordance with AREMA Communications and Signals Manual Part 11.1.1 (Recommended Functional/Operating Guidelines for Electrical Safety).

2. High Voltage lightning arrestors shall be applied to commercial power connections.

E. Grounding:

1. Provide a grounding system at each relay case as specified herein. The grounding system shall meet the requirements of AREMA Communications and Signals Manual, Part 11.4.1 (Recommended Instructions for Made Grounds for Signal Systems Utilizing Earth Electrodes), except as otherwise specified herein.
2. For each relay case, provide a ground grid consisting of at least 2 ground rods buried a minimum of 6 inches below finished grade, connected together with a 4/0 bare copper wire to form the grid.
3. The ground rod shall be copper-clad steel with a minimum length of ten feet, and a minimum diameter of 0.75 inch.
4. The ground rod to cable connection shall be by Thermite welding.
5. Provide a hard drawn pure copper ground bus plate for each relay case with a minimum size of 4-inches square and a minimum thickness of $\frac{3}{8}$ inches. This plate shall have a minimum conductivity of 98 percent per ASTM B187/B187M.
6. Connect the ground buss to the ground grid by a minimum of two #6 AWG solid copper conductors.
7. Test and measure ground resistance of each ground connection in an approved manner and shall add as many ground rods as necessary to achieve a resistance between the object being grounded and the ground not to exceed 15 ohms. This test shall be preformed in accordance with IEEE standard 81 requirements.
8. Install ground rods and the connections between arrestors and ground rods in accordance with AREMA Communications and Signals Manual Parts 11.2.1 (Recommended General Practices for Electrical Surge Protection for Signal Systems), 11.3.1 (Recommended Design Criteria and Functional/Operating Guidelines for Primary Surge Protectors for Electrical Surge Protection of a Signal System), and 11.3.2 (Recommended Design Criteria and Functional/Operating Guidelines for Secondary Surge Protectors for Electrical Surge Protection of Signal Systems) Protect all electronic equipment by surge suppressors in addition to primary lightning arrestors in accordance with AREMA Communications and Signals Manual Part 11.3.3 (Recommended Design Criteria for Surge Withstand Capability of Electronic Signal Equipment for Signal Systems).

F. Ground Detectors

1. Provide solid state DC ground detectors for each relay case which shall automatically provide a visual annunciation if any of the vital DC energy buses experiences a ground leakage current greater than or equal to 50 percent of the release value of any vital relay used in the system.
2. Furnish a separate ground detector meeting the following requirements for each DC voltage supply from which external safety circuits or equipment are operated.
 - a. Each DC ground detector unit shall be provided with three indications and a test control.
 - 1) Two indicators, one each for positive and negative, shall indicate the presence of a ground.
 - 2) The third indicator shall indicate that the ground detector is operating properly and no grounds are present.

- 3) The ground fault monitor shall have both an automatic and a manual self test feature and shall latch in the alarm mode if a ground fault is detected.
- b. Ground detectors shall be either rack or wall-mounted in relay cases.
- G. Cable Entrance Rack, Backboards, and Battery Boards
1. Cable entrance and termination racks shall be made of $\frac{3}{4}$ -inch thick non-combustible, moisture-resistant, fire retardant plywood meeting requirements of ASTM E 162 (Test Method For Surface Flammability Of Materials Using A Radiant Heat Energy Source), and ASTM E 662 (Test Method For Specific Optical Density of Smoke generated By Solid Materials); or other suitable equivalent such as "Transite HT" as manufactured by BNZ Materials, Inc.
 2. Mount the entrance and termination backboard on an equipment rack frame as approved by the Authority.
 3. Furnish entrance rack backboard large enough to accommodate all required terminals plus 10 percent spares.
 4. Terminate all conductors of all cables on the entrance rack. Terminals used to terminate spare conductors shall count towards the required 10 percent spares.
 5. All AAR terminals carrying greater than 50 volts shall be insulated.
 6. Separate and segregate equipment carrying more than 150 volts from all other equipment in that same relay case.
 7. Place conductors carrying more than 150 volts in conduit when inside of any relay case.
 8. Enclose equipment carrying more than 150 volts in a separate metal enclosure when inside of any relay case.

PART 3 - EXECUTION

3.1 SHIPPING AND INSTALLATION

- A. Plug-in relays and other equipment subject to damage shall be dismantled, placed in shipping cartons which shall prevent damage, secured and shipped in the relay case.
- B. Mount each relay case on standard pre-cast concrete foundations. Install the relay case in the area shown on the Contract Drawings and not less than 8 feet-6 inches from centerline of tracks at any point.
- C. Level and plumb each relay case and mount on an approved neoprene pad. Install the pad between the base of the relay case and the concrete foundation.

3.2 GROUNDING

- A. Ground rods shall be driven to a depth of 11 feet-6 inches and will be buried a minimum of six inches below the top of grade.
- B. In the event that an obstruction is encountered, the Contractor may use a shorter ground rod if it will result in at least 8 feet of the rod being usable after allowing for it to be buried the minimum of 6 inches below top of grade.
- C. Connect ground bus plate as specified above in each relay case to earth ground using two #6 AWG solid copper conductors.

- D. Ground wire for any equipment connected to ground plate shall be at least a #6 stranded bare copper wire.
- E. Prevent any closed loop arrangement in the grounding layout.
- F. Test and measure ground resistance in an approved manner (as detailed in IEEE standard 81) and shall add as many ground rods as necessary to achieve a resistance between the object being grounded and the ground not to exceed 15 ohms and shall meet the requirements of AREMA Communications and Signals Manual, Part 11.4.1 (Recommended Instructions for Made Grounds for Signal Systems Utilizing Earth Electrodes), except as otherwise specified herein.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

- A. The quantities of accepted work will be measured in the following units. All measurements will be plan measure except for authorized changes.
 - 1. Description: Lump Sum

4.2 PAYMENT

- A. Payment will be made at the respective unit or lump-sum price listed in the proposal and shall be full compensation for all labor, materials, and equipment necessary to complete the respective unit in place. There will be no separate measurement or payment for any item of work not specifically identified and listed in the proposal, and all such work shall be considered a subsidiary item with all costs pertaining thereto included in the prices for other items listed in the proposal. At the Engineer's option, partial payment may be made for any lump sum item listed in the proposal, providing that the Contractor is diligently and satisfactorily pursuing full completion of such partially complete item in accordance with the approved job progress schedule.

END OF SECTION

SECTION 34 42 36**SIGNALS SWITCH POINT HEATERS****PART 1 - GENERAL****1.1 SUMMARY**

- A. This Section includes the requirements for furnishing and installing the switch point heaters including control and indication elements.

1.2 RELATED SECTIONS

- A. SECTION 01 33 00 – Submittal Procedures
- B. SECTION 01 43 00 – Systems Quality Assurance
- C. SECTION 34 42 10 – Signals General Engineering and Design Requirements

1.3 SUBMITTALS

- A. Unless otherwise specified, all submittals shall be in accordance with SECTION 01 33 00 – Submittal Procedures and SECTION 34 42 10 – Signals General Engineering And Design Requirements.
- B. Switch Point Heater Data: Submit product data, including point heater controller, control cabinet, point heater elements, rail temperature sensor, and humidity sensor. Include product material specifications, drawings and parts lists.
- C. Switch Point Heater Installation Drawings: Submit an installation drawing for switch point heaters connections at the rail as well as for other associated equipment including temperature and humidity sensors necessary to completely identify the installation. Refer to Section 01 33 00 – Submittal Procedures, for additional requirements.

1.4 QUALITY ASSURANCE

- A. The Contractor shall comply with requirements of Division 1.

PART 2 - PRODUCTS**2.1 DESIGN REQUIREMENTS**

- A. General
 - 1. Switch point heaters shall keep track switch points clear of snow or ice to the extent necessary to permit free and unobstructed operation in all weather conditions. The Contractor shall install the switch point heaters in accordance with AREMA Communications and Signals Manual Part 12.6.10 (Recommended Functional/Operating Guidelines for Winter Switch Protection Devices) and the manufacturer's instructions, except as otherwise specified, or as approved by the Agency. Switch point heater mounting hardware shall not interfere with switch point movement and hardware.

2. Switch Point Heaters shall meet the following requirements:
 - a. The rail web heaters shall be operable at 230 VAC nominal. The Contractor shall ensure that the operating voltage of the heaters matches the source voltage available. The Contractor shall provide autotransformers if necessary to obtain the correct operating voltage for the switch point heaters.
 - b. The Contractor shall furnish and install point heaters of sufficient length to ensure the points of the switch machine are kept free and clear of ice and snow under all conditions.
 - c. The switch heaters shall include both rail temperature and humidity sensors.
 - d. The Contractor shall furnish, install, and test the switch point heaters as well as all associated sensors, cables, junction boxes, and installation hardware required to install the heaters.

B. Control Cabinet

1. The switch point heater control equipment shall be housed in a weatherproof case separate from any signal case in the area. The intent is that the Contractor shall furnish a standard, stand alone heater control cabinet manufactured by the same manufacturer as the switch point heaters.
2. The Contractor shall install the switch point heater control cabinet on the ground in close proximity to the switch points.
3. The Contractor shall be responsible to furnish and install a suitable concrete foundation to support the control cabinet.

2.2 MANUFACTURER'S REFERENCE

- A. Switch Point Heaters as manufactured by Hanning & Kahl, GmbH & Co KG. which is represented in North America by SECA International Railway Consultants, Inc. 885 Arvita Court Oceanside, Ca. 92057 Phone: 714-720-9129.
- B. Or accepted equal

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General: Install equipment in accordance with the manufacturer's recommendations and requirements, and as specified in these technical specifications.
- B. Switch point heaters shall be provided at four switches:
 1. The spring switch located at approximately 203+35
 2. The power turnout located at approximately 519+65
 3. The manual switches in the yard at approximately 23+32 and 24+12

PART 4 - MEASUREMENT AND PAYMENT**4.1 MEASUREMENT**

A. The quantities of accepted work will be measured in the following units. All measurements will be plan measure except for authorized changes.

1. Description: Lump Sum

4.2 PAYMENT

A. Payment will be made at the respective unit or lump-sum price listed in the proposal and shall be full compensation for all labor, materials, and equipment necessary to complete the respective unit in place. There will be no separate measurement or payment for any item of work not specifically identified and listed in the proposal, and all such work shall be considered a subsidiary item with all costs pertaining thereto included in the prices for other items listed in the proposal. At the Engineer's option, partial payment may be made for any lump sum item listed in the proposal, providing that the Contractor is diligently and satisfactorily pursuing full completion of such partially complete item in accordance with the approved job progress schedule.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 34 42 40

SIGNALS TAGS, LOCKS AND KEYS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes Specifications for furnishing and installing tags, locks and keys.

1.2 RELATED SECTIONS

- A. SECTION 01 33 00 – Submittal Procedures
- B. SECTION 01 43 00 – Systems Quality Assurance
- C. SECTION 34 42 10 – Signals General Engineering and Design Requirements

1.3 SUBMITTALS

- A. Unless otherwise specified, all submittals by the Contractor shall be in accordance with SECTION 01 33 00 – Submittal Procedures and SECTION 34 42 10 – Signals General Engineering And Design Requirements.
- B. The Contractor shall submit a sample of each type of tag for Approval.
- C. The Contractor shall submit padlock and key shop drawings and literature for Approval.

1.4 QUALITY ASSURANCE

- A. The Contractor shall comply with requirements of Division 1.

PART 2 - PRODUCTS

2.1 PLASTIC TAGS

- A. All plastic tags shall have a minimum font size of 10 points with a minimum spacing between lines of 7 points. A point is defined as 1/72 of an inch.
- B. All tags shall be waterproof and the lettering protected from fading and smudging.
- C. The lettering on all plastic tags shall be computer generated. No tags shall be hand lettered.
- D. Each flat tag shall have the following minimum characteristics:
1. White laminated phenolic or vinyl plastic, with black lettering
 2. A minimum of two holes for screw mounting
 3. Minimum thickness of 0.050 inches
- E. Each wire tag shall have the following minimum characteristics:
1. White vinyl plastic with black lettering, protected with a 0.005-inch clear overlamine.
 2. Minimum thickness of 0.020 inches

- 3. All corners rounded to an approximately 1/8-inch radius.
- F. Each cable tag shall have the following minimum characteristics:
 - 1. Same as wire tags, except attached to cable with pre-tied nylon cord loops.
- G. Each sleeve tag shall have the following minimum characteristics:
 - 1. White vinyl plastic with black lettering
 - 2. Lengths as required, minimum length 3/4 inch
 - 3. Diameter shall be selected for a snug fit on wire

2.2 METAL TAGS

- A. Each cast metal tag shall have the following minimum characteristics:
 - 1. Malleable cast metal
 - 2. Painted white
 - 3. Minimum height 3 inches
 - 4. Minimum thickness 1/16 inch
- B. Each brass tag shall have the following minimum characteristics:
 - 1. 1/4 inch high letters and numbers stamped onto the tag
 - 2. Sufficient size to contain required information, DANGER 750 VOLTS, without crowding
 - 3. Minimum thickness 1/32 inch
 - 4. All stencil markings shall be clearly legible and shall be made using white enamel paint.

2.3 LOCKS AND KEYS

- A. The Contractor shall provide padlocks per owner's requirements. Each key shall have the following minimum characteristics:
 - 1. The keys shall not be commercially duplicable
 - 2. Furnish two keys per lock that open all locks of that same type

PART 3 - EXECUTION

3.1 TAGGING

- A. The Contractor shall provide and install a unique equipment identification code for each type of fixed equipment and replaceable element. The identification code shall be up to ten digits in length. All wiring, including color coded wires, shall be tagged as detailed below.
- B. The Contractor shall install flat tags onto the following system components:
 - 1. Relays and relay plugboards to show relay designation
 - 2. Equipment to show equipment designation

- C. The Contractor shall install "three line" sleeve type wire tags on all wires.
 - 1. All wire tags shall contain three pieces of information.
 - a. Line one shall be the location of the wire on which the tag is being installed.
 - b. Line two shall be the circuit nomenclature that the wire is a part of.
 - c. Line three shall be the destination of the wire.
 - 2. Wire tags shall be installed in all of the following situations:
 - a. On terminal ends of all wires and cable conductors installed in the system
 - b. Adjacent to terminals or binding posts wherever possible
 - 3. Tags shall not slide off the wire when it is disconnected from its termination point.
- D. Install cable tags, showing unique cable identification, with pre-tied nylon cord loops on cable sheath near the pothead.
- E. Cast Metal Tags
 - 1. Install two letters, "N" and "R", at least 6 inches high and painted white at each switch point.
- F. Stenciling
 - 1. Field cases, junction boxes and switch machines using 1-1/2 inch lettering to identify location.

3.2 PADLOCKS

- A. Contractor shall install padlocks onto the following:
 - 1. Wayside relay cases, cases and junction boxes
 - 2. Terminal cases
 - 3. Signal heads
 - 4. Switch machines, circuit controllers, etc., and associated equipment cases
- B. The Contractor shall provide locks and keys for the various applications as detailed below. Update this table when information is available.

Usage	Lock Type & Manufacturer	Quantity	Key Code	Key/wrench Quantity	Remarks
Signals	Coordinate with the owner	3 per signal	NA	1 per signal	
Mainline Switch Machine – Operating & Hand Throw Levers	Coordinate with the owner	1 per switch	NA	2 per switch	
Mainline Switch Machine – Access Panel & Terminal Box	Coordinate with the owner	2 per switch	NA	1 per switch	
Point Detectors	Coordinate with the owner	1 per circuit controller	NA	1 per circuit controller	
Cases	Coordinate with the owner	1 per door	NA	2 per door	
Spares	Coordinate with the owner	10% of total number of locks supplied	NA	20% of the total number of keys supplied	

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

A. The quantities of accepted work will be measured in the following units. All measurements will be plan measure except for authorized changes.

1. Description: Lump Sum

4.2 PAYMENT

A. Payment will be made at the respective unit or lump-sum price listed in the proposal and shall be full compensation for all labor, materials, and equipment necessary to complete the respective unit in place. There will be no separate measurement or payment for any item of work not specifically identified and listed in the proposal, and all such work shall be considered a subsidiary item with all costs pertaining thereto included in the prices for other items listed in the proposal. At the Engineer’s option, partial payment may be made for any lump sum item listed in the proposal, providing that the Contractor is diligently and satisfactorily pursuing full completion of such partially complete item in accordance with the approved job progress schedule.

END OF SECTION

SECTION 34 42 44**SIGNALS POWER DISTRIBUTION****PART 1 - GENERAL****1.1 SUMMARY**

- A. This Section includes Specifications for the furnishing and installation of the power distribution for signal equipment, including feeders, buses, transformers, ground detectors and associated auxiliary materials and equipment. The Contractor shall be responsible to furnish, install, wire, and test all power distribution equipment as detailed below including obtaining the actual power drop from the local power company. The Contractor shall also be responsible to provide documentation to show that all components of the power distribution systems are sized adequately.

1.2 RELATED SECTIONS

- A. SECTION 01 33 00 – Submittal Procedures
- B. SECTION 01 43 00 – Systems Quality Assurance
- C. SECTION 34 42 10 – General Engineering and Design Requirements
- D. SECTION 34 42 16 – Wire and Cable
- E. SECTION 34 42 29 – Electrical and Electronic Components
- F. SECTION 34 42 33 – Prefabricated Relay Cases
- G. SECTION 34 42 76 – Tests and Inspections

1.3 SUBMITTALS

- A. Unless otherwise specified, all submittals shall be in accordance with SECTION 01 33 00 – Submittal Procedures and SECTION 34 42 10 – Signals General Engineering And Design Requirements.
 - 1. The Contractor shall submit computations of the AC and DC power requirements for each signal equipment location.
 - 2. The Contractor shall submit drawings showing power layout of feeders, transformers, switches, fuses, breakers and buses internal to the relay case.
 - 3. The Contractor shall submit drawings of DC power supplies showing mechanical and electrical characteristics, performance data and method of protection.
 - 4. The Contractor shall submit as-built drawings of all power distribution circuitry and equipment installations internal to the relay case.

1.4 QUALITY ASSURANCE

- A. The Contractor shall comply with requirements of Division 1.
- B. The Contractor shall perform field testing as specified in SECTION 34 42 76 – Signals Tests And Inspections.

1.5 POWER DISTRIBUTION CRITERIA

- A. The Contractor shall provide each relay case with AC power.
1. For all relay cases the Contractor shall;
 - a. Coordinate with the local power company on the drop location
 - b. Obtain the necessary permits
 - c. Furnish and install the required conduit from the power company's point of demarcation to the relay case load center including service cable, meter pan and service disconnect switch per the latest edition of the NEC.
 - d. Provide load calculations confirming all of the required amperages needed for each relay case for sizing the service cable and main breaker in the case.
 - e. Furnish and install the relay case and all the necessary power distribution equipment within the relay case up to and including the load center.
 2. The following requirements shall apply to all relay cases:
 - a. The incoming AC power will terminate in a standard load center that shall have sufficient space to accommodate all of the required breakers plus a minimum of 50% spare spaces.
 - b. The load center shall provide separate breakers for:
 - 1) Relay case lighting and convenience outlets
 - 2) Relay case ventilation
 - 3) Switch heater cabinets at locations with switch heaters
 - c. The Contractor's power calculations shall determine the size of the breakers required.
 - d. The load center breakers shall feed a bank of indicating type fuses, which shall in turn distribute the AC power throughout the case as required.
- B. Power Calculations
1. The Contractor shall be responsible to calculate the load of each relay case.
 2. The Contractor shall compute the size of the power distribution system required to feed equipment.
 3. The Contractor shall design the complete power layout of feeders, transformers, fuses and buses, based on locations and size of individual signal loads.
 4. The Contractor shall size feeders to carry the rated load plus 15% for future load, with a voltage drop of not more than 4%, except that no feeder shall be smaller than #6 AWG. The feeders shall be sized so as to be able to carry a load equal to 125% of the total load that will be imposed by the portion of the system to be fed.
 5. The Contractor's calculations shall assume a worst case load, including case lighting is on, all signals are lit, maximum microprocessor/relay load, maximum track circuit load, switches are moving and drawing 14 Amps each, all power supplies are drawing their maximum rated current, switch heaters are on, and a 6 Amp draw from case convenience outlets.

6. The Contractor's calculations shall demonstrate that:
 - a. The incoming service feed is adequately sized.
 - b. The fuses, buss feeder wires, transformers, DC power supplies, etc., are adequately sized.
 - c. The proposed power distribution system meets the requirements detailed in the Specification.
 7. The Contractor's calculations shall demonstrate that the batteries supplied are of sufficient capacity to provide for the required 8 hours of normal Street Car system operation in the event of loss of commercial AC power. The calculations shall:
 - a. Assume one train movement in each direction every 15 minutes continuously over the 8 hour period.
 8. The Contractor shall submit these calculations and the system design to the Agency for Approval prior to purchasing any equipment.
- C. Lightning and Transient Protection
1. All relay cases shall be designed, fabricated and installed in accordance with AREMA Communications and Signals Manual Part 11.1.1 (Recommended Functional/Operating Guidelines for Electrical Safety), except as otherwise specified herein, or as Approved by the Agency.
 2. All track circuits shall be protected from lightning per AREMA Communications and Signals Manual Part 11.3.1 (Recommended Design Criteria and Functional/Operating Guidelines for Primary Surge Protectors for Electrical Surge Protection of Signal Systems), except as otherwise specified herein, or as Approved by the Agency.
 3. All ground rods and the connections between arrestors and ground rods shall be installed in accordance with AREMA Communications and Signals Manual Parts 11.2.1 (Recommended General Practices for Electrical Surge Protection of Signal Systems), 11.3.1 (Recommended Design Criteria and Functional/Operating Guidelines for Primary Surge Protectors for Electrical Surge Protection of Signal Systems), 11.3.2 (Recommended Design Criteria and Functional/Operating Guidelines for Secondary Surge Protectors for Electrical Surge Protection of Signal Systems), 11.3.4 (Recommended Design Criteria for Copper Clad Steel Ground Rods and Connections for Signal Systems) and 11.3.5 (Recommended Design Criteria for Chemically Enhanced Ground Electrode Systems for Signal Systems), except as otherwise specified herein, or as Approved by the Agency.
 4. All electronic equipment shall be protected by surge suppressors in addition to primary lightning arrestors in accordance with AREMA Communications and Signals Manual Part 11.3.3 (Recommended Design Criteria for Surge Withstand Capability of Electronic Signal Equipment for Signal Systems) and Part 11.3.6 (Recommended Design Criteria and Function for Solid State AC Primary Surge Protective Devices (SPDs) for Communication and Signal Systems), except as otherwise specified herein, or as Approved by the Agency.
 5. High voltage lightning arrestors shall be applied to commercial connections.

D. Relay Case and Junction Box Wiring

1. The Contractor shall comply with the requirements of this Section for all relay case and junction box wiring.
2. All cable conductors, including spare conductors provided over and above the Contract requirements shall be terminated on multiple unit AREMA (AAR) terminal blocks in accordance with AREMA Communications and Signals Manual Part 14.1.8 (Recommended Design Criteria for Molded Binding Post Type Terminal Block, Details and Assemblies). Track wires and cables may be terminated on lightning arrestors.
3. If energy is distributed to various points in a relay case or junction box by wire loops, the details of each loop and its various connections shall be illustrated on the circuit plans. Such loops shall have both ends connected to the buss.
4. If the same energy source is needed at various points in the relay case power loop shall be created. Minimum wire size for the power loop shall be #10. The Contractor shall ensure that voltage loss within the wiring of the buss does not affect the operation of the equipment that the buss is powering. Calculations shall be based upon the assumption that the incoming power may sag up to 10%.
5. Both ends of all wires and terminal boards shall be tagged with nomenclature, which is shown on the circuit plans. Tags shall be permanent, non-conductive, and attached to the wire and terminal board so as not to be easily removed.

PART 2 - PRODUCTS**2.1 POWER CABLE**

- A. Power cable for distribution of power to signal equipment locations and highway grade crossing warning system equipment locations shall be as specified in SECTION 34 42 16 – Signals Wire And Cable.

2.2 POWER EQUIPMENT**A. DC Power Supplies**

1. Shall be as specified in SECTION 34 42 29 - Signals Electrical and Electronic Components.
2. In addition to any other power supplies required by the Contractor's design, the Contractor shall provide a separate Line Battery (LB) supply. This power supply shall be used exclusively to supply DC power to loads outside of the relay case other than signal bulbs. Such loads shall include but not be limited to:
 - a. Switch indication circuits
 - b. Line circuits
3. In addition to any other power supplies required, the Contractor shall provide a separate Signal Lighting Battery (EB) supply. This supply shall be used exclusively to provide power to light wayside signals.

B. Batteries

1. Back-up batteries shall be furnished for each relay case.
2. Batteries shall be added in parallel as needed to provide a minimum of 8 hours of normal equipment operation without AC power.

3. Batteries shall be sealed lead acid batteries in accordance with AREMA Communications and Signals Manual Part 9.1 (Recommended Batteries), except as otherwise specified, or as Approved by the Agency.
 4. The batteries shall be Optima Gel model D34M-950 or approved equal.
- C. Battery Chargers
1. One battery charger shall be furnished for each set of backup batteries.
 2. The battery chargers shall be NRS (National Railway Supply) model ERB-C 12/20 or approved equal.
- D. Transformers
1. All transformers shall be of the air cooled, dry type conforming to AREMA Communications and Signals Manual, Part 14.2.10 (Recommended Design Criteria for Transformer, Dry-Type, Air-Cooled) and NEMA ST 20-1992 (R1997), appropriately de-rated per ANSI C.57.12.01 for altitude above 3,300 feet, except as otherwise specified herein, or as Approved by the Agency.
 2. All transformers shall be sized for 125% of the normal continuous load, and shall be equipped with taps sufficient to adjust for line losses and normal voltage variations. Primary and secondary taps shall be brought to a terminal board mounted on the transformer case. Taps shall be labeled on the terminal board with respect to voltage.
 3. Power frequency track circuit transformers shall have an input of 120 Volts, 60 Hz and an adjustable output. Secondary windings shall be provided with taps to supply voltages in steps as Approved by the Agency. Taps shall be provided in the primary windings for 110 Volts and 115 Volts. Track transformers shall be capable of carrying the track circuit load plus 25% overload.
 4. Flux density shall be sufficiently below saturation to allow a minimum of 10% over-voltage excitation.
 5. Noise level shall not exceed limits set by local regulations, and shall not exceed the following, as determined in accordance with NEMA ST 20-1992 (R1997):
 - a. For transformers sized 0 to 9 kVA: 40 dBA sound level
 - b. For transformers sized 10 kVA to 50 kVA: 45 dBA sound level
 - c. For transformers sized 51 kVA and above: 50 dBA sound level
 6. Finishes: Thoroughly cleaned, degreased, coated with hot phosphate chemical bath, corrosion inhibiting primer or undercoat, and overall finish coat of manufacturer's standard electrical paint. Colors as Approved by the Agency.
- E. Switch Heater Transformers
1. It expected that in most cases the AC power available to power the switch heaters will be 240 VAC. The Contractor shall furnish and install an appropriately sized transformer to convert the incoming AC service voltage to the voltage required by the switch heaters.

F. Indicating Fuses

1. The Contractor's power calculations shall determine the size of the individual fuses required. All fuses shall meet the following requirements:
 - a. Fuses shall be fiber-case, non-renewable, time-lag, fusion, indicating type.
 - b. Shall be the correct size and rating to protect the wiring of the circuit they are in.
 - c. If in a circuit carrying more than 50 Volts, the fuse block shall be provided with a clear plastic cover to reduce shock hazard.
 - d. The fuses shall be constructed in such a way that it is readily apparent from a visual inspection whether a fuse is blown or not.
 - e. The blown fuse indications shall be collected and used to drive the "Blown Fuse" indication on the local control panel.
 - f. All fuses shall be centrally located on the power distribution panels or power racks.

PART 3 - EXECUTION**3.1 POWER EQUIPMENT****A. Power Supplies**

1. All power supplies shall be either wall, shelf or rack mounted.

B. Transformers

1. The Contractor shall install transformers in accordance with the manufacturer's instructions.
2. Flexible metal conduit not less than 18 inches or more than 36 inches in length shall be used to connect to conduits unless otherwise Approved by the Agency.
3. The Contractor shall verify that all circuits are connected as shown on the Contract Drawings.
4. The Contractor shall perform insulation and circuit continuity tests prior to connecting primary service.

C. Grounding

1. Grounding shall be as specified in SECTION 34 42 33 PREFABRICATED RELAY CASES.

PART 4 - MEASUREMENT AND PAYMENT**4.1 MEASUREMENT**

A. The quantities of accepted work will be measured in the following units. All measurements will be plan measure except for authorized changes.

1. Description: Lump Sum

4.2 PAYMENT

A. Payment will be made at the respective unit or lump-sum price listed in the proposal and shall be full compensation for all labor, materials, and equipment necessary to complete the respective unit in place. There will be no separate measurement or payment for any item of work not specifically identified and listed in the proposal, and all such work shall be considered a subsidiary item with all costs pertaining thereto included in the prices for other items listed in the proposal. At the Engineer's option, partial payment may be made for any lump sum item listed in the proposal, providing that the Contractor is diligently and satisfactorily pursuing full completion of such partially complete item in accordance with the approved job progress schedule.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 34 42 52**SIGNALS POWER SWITCH AND LOCK MACHINES****PART 1 - GENERAL****1.1 SUMMARY**

- A. This Section includes requirements for furnishing power switch and lock machines and associated layouts for embedded track.

1.2 RELATED SECTIONS

- A. SECTION 01 33 00 – Submittal Procedures
- B. SECTION 01 43 00 – Systems Quality Assurance
- C. SECTION 34 42 10 – Signals General Engineering and Design Requirements
- D. SECTION 34 42 25 – Signals Relays and Plugboards
- E. SECTION 34 42 68 – Signals Circuit and Operational Requirements.
- F. SECTION 34 42 76 – Signals Tests and Inspections

1.3 QUALITY ASSURANCE

- A. The Contractor shall comply with the requirements of Division 1. The Systems Contractor shall also conduct tests for all wayside signal equipment in accordance with SECTION 34 42 76 – Signals Tests And Inspections.

1.4 REFERENCES

- A. American Railway Engineering and Maintenance-of-Way Association, Communications & Signals Manual of Recommended Practice [AREMA C&S Manual]
 - 1. AREMA C&S MANUAL, PART 1.5.10 – Recommended Instructions for Painting and Protective Coatings.
 - 2. AREMA C&S MANUAL, PART 14.1.8 – Recommended Design Criteria for Molded Binding Post Type Terminal Block, Details and Assemblies.

1.5 SUBMITTALS

- A. Unless otherwise specified, all submittals shall be in accordance with
 - 1. Switch Machine Product Data: Submit performance data, and mechanical and electrical drawings, for each type of switch machine, including interconnecting rods and all associated hardware. Include parts list, and switch numbers and letters
 - 2. Earth Box: Submit product data for earth boxes in accordance with the requirements of this Section.
 - 3. Junction Boxes: Submit product data for junction boxes in accordance with the requirements of this Section.

4. Switch Machine Installation Drawings: Submit an installation drawing for each type of switch installation. Include switch layout, mounting material and methods (including method of insulating installation from track), corrosion preventive grease, junction box locations, identification numbers and letters, signal or switch point indicator locations (as applicable), and all other associated equipment and conditions necessary to completely identify the installation
5. Switch Machine Mounting Details: Submit, for each type of switch machine (and switch circuit controller if applicable) to be provided, mounting hole layouts for the trackwork procurement contractor to provide the concrete switch ties with insulated embedded threaded female inserts to suit the switch machine mounting holes.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Power Switch and Lock Machines: Furnish and install embedded power-operated switch machines where indicated in the Contract Drawings.
- B. Manual Switch and Lock Machines: Provide embedded hand-operated switch machines where indicated in the drawings that accompany this Request for Proposal. These machines shall be suitable for spring-type operation.
- C. Insulation: Supply insulators to electrically insulate the switch machine layout from the running rails.
- D. Operating Voltage:
 1. Switch machines shall be rated for operation at either 120 VAC or 240 VAC. Switch operating voltage shall be measured at the motor connection while switch is moving.
- E. Point Detection and Indication
 1. Provide point detection and indication in accordance with the requirements of Section 34 42 68 – CIRCUIT AND OPERATIONAL REQUIREMENTS.
- F. Layout
 1. The switch layout shall include (as applicable) housing with non-rusting cover, earth case, junction boxes, mounting brackets, conduit, hoses, tubing, terminals, hardware, and all other electrical materials and fittings necessary to interconnect the track switch machine to the ductbank and the relay case.
 2. All rods shall be standard in design. No bending of rods shall be permitted to complete an installation.
 3. Switch machines, their accessories, and the connections to the track switch, shall be compatible with the conditions of the embedded special track work.
- G. Identification
 1. Power Switch and Lock Machines: Provide embedded power-operated switch machines where indicated in the drawings that accompany this Request for Proposal.
 2. For each embedded type switch machine stencil the switch number on the switch machine earth box cover plate. Coordinate size, lettering, and placement with the Resident Engineer.

- H. Relays: Provide relays for switch control in accordance with the requirements of Section 34 42 25 – RELAYS AND PLUGBOARDS. As an alternative, submit a solid state equivalent for this function for approval
- I. Lubricant: Provide a “dry” graphite based switch plate lubricant common to the railroad industry. Motor oil or any lithium or similar petroleum-based “bearing” greases is not permitted.
- J. Padlocks: Provide padlocks for motor compartments, hand throw levers, switch machine junction boxes, and circuit controller enclosures, as applicable, in accordance with the requirements of Section 34 40 42 TAGS, LOCKS, AND KEYS..

2.2 MANUFACTURER’S REFERENCE

- A. Power Machines
 - 1. Contec GmbH is represented in North America by H. J. Skelton (Canada) Ltd., 165 Oxford Street, East London, Ontario N6A 1T4 Canada. Phone 1-877-235-1883
 - a. Model CSV 24, accepted
 - 2. Hanning & Kahl, GmbH & Co KG. is represented in North America by SECA International Railway Consultants, Inc. 885 Arvita Court Oceanside, Ca. 92057 Phone: 714-720-9129
 - a. Model HWE 61, accepted
 - 3. Or accepted equal
- B. Hand Operated Spring and Return Machines:
 - 1. Hanning & Kahl GmbH & Co KG is represented in North America by SECA International Railway Consultants, Inc. 885 Arvita Court Oceanside, Ca. 92057 Phone: 714-720-9129
 - a. Model HWU42 Slap/Return
 - b. Or accepted equal

2.3 DETAILS OF DESIGN

- A. Furnish switch machine and earth box with the shallowest possible height to reduce concrete penetration.
- B. Switch Machine:
 - 1. Switch Point Indication: Provide an electro-mechanical switch machine design with a double interlocking point setting mechanism and point detectors.
 - 2. Provide two (2) hardwearing, inductive proximity switches to sense the switch point position of both normal and reverse indications respectively, for signaling the correct position of end points and the downward locking movement.
 - 3. Provide point position indicator signal as an integral part of the machine.
 - 4. Throwing force: 5000N, minimum, and adjustable up to 7000N.
 - 5. Holding force shall be not less than 7000N.
 - 6. Include positive locking on the drive and point detector.

7. If furnishing the Hanning and Kahl HWE-61 switch machine also furnish the Harting Cable to power the machine.
- C. Earth Box:
1. Design the earth boxes for the switch machines to accommodate the internal housing of the point setting mechanism. If furnishing the Hanning and Kahl HWE-61 switch machine, furnish the "large" earth box to accommodate future switch machine changes.
 2. Design both the earth box and the surface cover to be capable of supporting AASHTO HS20 loading.
 3. Design the cover to be fastened to the earth box with 4 bolts, minimum.
 4. Design the earth box assemblies to provide electrical isolation from the switch housing and the track slab.
 5. Design the insulated contact connection (bolted) of the earth box to the switch housing.
 6. Color: Provide the earth box cover of a color to match the surrounding embedment concrete.
 7. Drainage: Design the earth box for drainage system via a floor drain connection as shown on the Plans.
 8. Earth Box Materials: Reinforced polyester concrete formulation of polyester resins as follows:
 - a. "High Density Polymer Concrete", a Synertech Molded Product by Oldcastle Precast, Chicago, IL 60604, telephone (773) 622-1177, or accepted equal.

PART 3 - EXECUTION

3.1 DELIVERY, STORAGE, AND HANDLING

- A. Packaging:
1. Prior to shipment, coat all unpainted metal parts of the switch machine and layouts with accepted corrosion preventive grease sufficient to prevent corrosion, in accordance with manufacturer's recommendations.
 2. Ship each unit securely wrapped, crated or packaged; and labeled to avoid damage or distortion and for safe handling in shipment.
 3. Suitably plug or cap all unused threaded outlets.
 4. Package all small parts in containers such as boxes, crates, or barrels to avoid dispersal and loss.
 5. Firmly secure an itemized list and description of contents to each such container.
 6. Protect projecting parts by blocking with wood, by providing bracing, or by other accepted methods.

- B. Ocean Shipments:
1. Ship materials in suitable crates or in ocean going cargo containers. Do not ship open or palletized in general cargo area of the hold of the ship.
 2. Implement protective measures so as to prevent damage in shipping due to salt water, salt spray, humidity, shifted cargo, and similar causes.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

- A. The quantities of accepted work will be measured in the following units. All measurements will be plan measure except for authorized changes.
1. Description: Lump Sum

4.2 PAYMENT

- A. Payment will be made at the respective unit or lump-sum price listed in the proposal and shall be full compensation for all labor, materials, and equipment necessary to complete the respective unit in place. There will be no separate measurement or payment for any item of work not specifically identified and listed in the proposal, and all such work shall be considered a subsidiary item with all costs pertaining thereto included in the prices for other items listed in the proposal. At the Engineer's option, partial payment may be made for any lump sum item listed in the proposal, providing that the Contractor is diligently and satisfactorily pursuing full completion of such partially complete item in accordance with the approved job progress schedule.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 34 42 56

SIGNAL LAYOUTS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the requirements for furnishing and installing wayside signals and associated accessories, to be provided in the Contract.

1.2 RELATED SECTIONS

- A. SECTION 01 33 00 – Submittal Procedures
- B. SECTION 01 43 00 – Systems Quality Assurance
- C. SECTION 34 42 40 – Signals Tags, Locks, and Keys
- D. SECTION 34 42 68 – Signals Circuit and Operational Requirements
- E. SECTION 34 42 76 – Signals Tests and Inspections

1.3 REFERENCES

- A. American Railway Engineering and Maintenance-of-Way Association, Communications & Signals Manual of Recommended Practice [AREMA C&S Manual]
 - 1. AREMA C&S MANUAL, PART 1.5.10 – Recommended Instructions for Painting and Protective Coatings

1.4 SUBMITTALS

- A. Unless otherwise specified, all submittals shall be in accordance with SECTION 01 33 00 – Submittal Procedures and SECTION 34 42 10 – Signals General Engineering and Design Requirements.
- B. Signal Product Data: Submit complete drawings of each type of signal layout to be used, including all mounting and wiring. Include all necessary product material drawings, signal identification sign, and part lists.
- C. Signal Installation Drawings: Submit installation drawings for each type of signal layout. Refer to Section 01 33 00 – Submittal Procedures, for additional requirements.

1.5 QUALITY ASSURANCE

- A. The Contractor shall comply with requirements of Division 1.
- B. The Contractor shall factory test all electrical and electronic components prior to installation in accordance with manufacturer's test procedures and provisions of SECTION 34 42 76 - Signals Tests And Inspections.

PART 2 - PRODUCTS**2.1 GENERAL**

- A. Visibility: Signals and indicators shall be designed to be located so that the unit shall provide a distinct and unmistakable aspect at a distance of 300 feet.
- B. Mounting: Wayside signals may be mounted on nearby OCS poles or separate signal poles. Contractor to do final design and submit to the Project Manager for Approval
- C. Grounding: Signals to be grounded to 25 ohms or less.
- D. Painting: Paint housings and mounting hardware a non-reflecting dull grey, in accordance with AREMA C&S Manual, Part 1.5.10 Recommended Instructions for Painting and Protective Coatings.

2.2 SIGNALS

- A. General: Signals shall be 3 aspect bar signal (horizontal, 45°, and 90°) and be manufactured such that they are capable of being mounted on a variety of diameter poles. The intent is to mount the signals on nearby OCS poles or separate signal poles based on the contractor's final design. Contractor to coordinate with OCS pole and foundation design if mounting on OCS poles is desired.
 - 1. The signals shall be supplied by Hanning & Kahl or "owner approved equal".
- B. Layout:
 - 1. Provide signals general locations indicated on the Contract Drawings. Coordinate final locations with the facilities designs.
 - 2. Layouts shall be completely equipped with LEDs (unless approved or specified otherwise), terminals, number plates, and all other mounting hardware and components to complete the installation.
 - 3. Housings shall permit easy access to internal components. Each unit shall be factory wired and pre-focused.
 - 4. Signals shall be powered from the applicable microprocessor-based system output, when practical. Where distances between signals and the controlling relay case do not permit the use of a direct feed from the vital microprocessor (e.g., 120 VAC feed required), furnish and install all required equipment, including isolation transformer, necessary to provide a complete and operational system.

PART 3 - EXECUTION**3.1 INSTALLATION**

- A. General
 - 1. Install in accordance with approved Contractor-provided installation plan and drawings, and in accordance with the requirements of the Contract Drawing Typical Installation Drawings.
- B. Clearance Requirements: The design and installation of the equipment shall not interfere with the dynamic clearance of the vehicle.
- C. Security: Provide locks and/or other security in accordance with the requirements of SECTION 34 42 40 – Signals Tags, Locks, And Keys.

- D. Identification:
1. Include signal identification number as a part of the signal layout. Face the identification number in the direction that allows it to be read by the vehicle operator.
 2. Coordinate size, lettering, and placement with the Resident Engineer.
- E. Test: Test signals and indicators in accordance with the requirements of Section 34 42 76 –Signals Tests And Inspections.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

- A. The quantities of accepted work will be measured in the following units. All measurements will be plan measure except for authorized changes.
1. Description: Lump Sum

4.2 PAYMENT

- A. Payment will be made at the respective unit or lump-sum price listed in the proposal and shall be full compensation for all labor, materials, and equipment necessary to complete the respective unit in place. There will be no separate measurement or payment for any item of work not specifically identified and listed in the proposal, and all such work shall be considered a subsidiary item with all costs pertaining thereto included in the prices for other items listed in the proposal. At the Engineer's option, partial payment may be made for any lump sum item listed in the proposal, providing that the Contractor is diligently and satisfactorily pursuing full completion of such partially complete item in accordance with the approved job progress schedule.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 34 42 58**SIGNALS TRACK CIRCUITS AND BONDING****PART 1 - GENERAL****1.1 SUMMARY**

- A. This Section includes:
 - 1. Requirements for furnishing and installing power frequency (PF) track circuit equipment
 - 2. Requirements for power bonding at turnout locations
 - 3. Requirements for crossbonding

1.2 RELATED SECTIONS

- A. SECTION01 33 00 – Submittal Procedures
- B. SECTION01 43 00 – Systems Quality Assurance
- C. SECTION34 42 10 – Signals General Engineering and Design Requirements
- D. SECTION34 24 25 – Signals Relays and Plugboards
- E. SECTION34 42 40 – Signals Tags, Locks, and Keys
- F. SECTION34 42 76 – Signals Tests and Inspections

1.3 REFERENCES

- A. American Railway Engineering and Maintenance-of-Way Association, Communications & Signals Manual of Recommended Practice [AREMA C&S Manual]
 - 1. AREMA C&S MANUAL, PART 8.1.33 – Recommended Design Criteria for Copper Based Exothermically Welded-Type Propulsion Rail-Web Bonds and Track Connections.

1.4 SUBMITTALS

- A. Unless otherwise specified, all submittals shall be in accordance with SECTION01 33 00 – Submittal Procedures and SECTION 34 42 10 – Signals General Engineering And Design Requirements.
- B. Track Circuit Product Data: Submit product data for each type of track circuit. Include as a minimum, parts lists, circuit drawing and description identifying that shunting and other performance requirements have been met, and component drawings and data. Identify pre-shunt and post-shunt characteristics.
- C. Power Bonding Product Data: Submit product data on each type of bond. Include as a minimum catalog, data, exothermic weld material, mold numbers, and manufacturer's installation data.
- D. Track Circuit and Power Bonding Installation Drawings: Submit installation drawings identifying the proposed track circuit and power bonding layouts for each turnout.

- E. Insulated Joint Location Documentation: Submit documentation that the locations of all insulated joints indicated on the Contract Drawings are acceptable for the Contractor's proposed signal design. Indicate additions, deletions, or relocations, if required.
- F. Relay Product Data: Submit relay product data in accordance with SECTION 34 42 25 – Signals Relays And Plugboards.

1.5 QUALITY ASSURANCE

- A. The Contractor shall comply with requirements of Division 1.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Design
 - 1. Furnish and install track circuits, including all associated hardware to complete the installation. The Signal System indicated in the Contract Documents is a preliminary design and indicates intended functionality. The Contractor shall complete the final design as required in order to provide a fully operational, flexible, reliable and safe Signal System that conforms to all applicable parts of the AREMA C&S Manual, Section 8.
 - 2. Track circuits shall function to provide continuous train detection throughout the entire length of the circuit whenever a shunt of 0.20 ohms (Ω) is applied to the rails at any location within the track circuit boundary, including shunt fouling regions within turnouts. Assume the following rail to ground resistance values:
 - a. Ballasted Track - 250 ohms per 1000' of double track system.
 - b. Direct Fixation - 250 ohms per 1000' of double track system.
 - c. Embedded Track - 100 ohms per 1000' of double track system.
 - 3. The design of track circuits in crossovers shall minimize dead sections through the interlocking to the maximum extent possible.
 - 4. Does not use shunt fouling in turnouts. Instead provide a track circuit which either uses two relays or arranges insulated joints to provide a series track circuit.
 - 5. The Contractor's designs shall provide for all design details, including insulated joints, operating voltages, filtering, frequency separation, impedance matching, surge protection, cable and wiring, and all related items required to ensure properly operating, safe, reliable, and low maintenance track circuits.
- B. Operating Temperature Ranges: Wayside equipment shall operate normally within the temperature ranges specified in SECTION 34 42 10 – Signals General Engineering And Design Requirements.
- C. Interference and Protection
 - 1. The design of all wayside signaling equipment shall incorporate electro-magnetic compatibility concepts to minimize potential interference from within the Signal System and nearby electrical systems.
 - 2. No vital signal relays, filters, modules, or other components shall have an operating frequency within the harmonic spectrum of the DC traction power transformer/rectifier harmonic output.

3. The equipment shall not generate spurious emissions, or introduce interference in other systems. The equipment shall be electro-magnetically compatible with other systems and equipment in its environment.
 4. Other than for primary protection, surge protection shall be built-in to the equipment. All external connections shall be via standard AREMA terminals.
 5. The Contractor shall ascertain if there are any facilities in proximity along the right of way, where the equipment is to be applied, that may adversely affect the equipment or system operation. If necessary, steps shall be taken to preclude interference with system operation.
- D. Insulated Joints
1. Preliminary insulated joint locations have been indicated on the Contract Drawings. Final circuit design, drawings, and coordination with the Trackwork Contractor (via the AGENCY), shall be the responsibility of the Contractor.
 2. Should the design require additional insulated joints, or relocation or deletion of existing joints the Contractor shall coordinate final locations with the Resident Engineer.
- E. Relays: Refer to SECTION 34 42 25 – Signals Relays And Plugboards, for requirements.

2.2 POWER FREQUENCY TRACK CIRCUITS

- A. Design
1. Equipment shall operate normally from a range of 90 VAC to 130 VAC.
 2. The signal system shall use single ac track circuits for main line train protection, as indicated on the Contract Drawings. Review the functional design indicated and propose a design that provides the functionality specified.
 3. Track circuit limits shall be as defined by the insulated joints, and track circuit detection shall extend to cover the clear point of tracks connected to the main line.

2.3 CROSSBONDS

- A. The only crossbonding associated with the signal system will be just beyond the insulated joints that define the OS track circuits.
- B. The Contractor shall furnish, install, and test 2-500 KCMIL jumpers to electrically connect all of the rails together just beyond the insulated joint at the OS track circuits.
- C. Welds: Provide rail welds meeting the requirements of AREMA C&S Manual, Part 8.1.33 Recommended Design Criteria for Copper Based Exothermically Welded-Type Propulsion Rail-Web Bonds and Track Connections.

2.4 POWER AND SIGNAL RAIL BONDING

- A. General: Furnish and install bonding for special trackwork, as indicated in Contract Drawing Typical Installation Plans. Bonds shall be applied to all bolted rail joints.
- B. Power and Signal Rail Bonding: Install in accordance with the Contract Drawing Typical Installation Drawings.
- C. Welds: Provide rail welds meeting the requirements of AREMA C&S MANUAL, Part 8.1.33 Recommended Design Criteria for Copper Based Exothermically Welded-Type Propulsion Rail-Web Bonds and Track Connections.

PART 3 - EXECUTION**3.1 GENERAL**

- A. Clearance Requirements: The design and installation of the equipment shall not interfere with the dynamic clearance of the vehicle.
- B. Security: Provide locks and/or other security in accordance with the requirements of Section 34 42 40 – Signals Tags, Locks, And Keys.
- C. Installation
 - 1. Install per the approved Contractor-provided installation drawings.
 - 2. Preparation of the running rail and the installation of the rail connections shall be in accordance with the bond manufacturer's recommendations unless otherwise specified. Rail surfaces that will be in contact with molten metal during welding shall be ground to remove all rust and deposits. Clean welds of all slag and debris. Inspect each bond to ensure that a properly fused joint has been made. Bond connections to the rails shall be exothermically welded to the neutral axis of the rails.
 - 3. Exposed copper shall be painted with an approved non-oxide grease within 8 hours of installation of bonds. Bonds shall be lubricated to prevent internal friction.
- D. Insulated Joint Locations: Provide final locations of required insulated joints to the Resident Engineer as specified so as to minimize impacts to work by others on the project.
- E. Protection of Ballast: The Contractor shall take all of the necessary precautionary measures to ensure that track ballast is not fouled (contaminated with dirt or sub-ballast) during the course of his work. The Contractor shall minimize any disruption to the ballast after it has been dressed by the preceding facilities contract, and shall be responsible to re-dress any ballast that has been disturbed.

3.2 TRACK CIRCUITS

- A. General
 - 1. Track circuit connections shall include installation of flexible conduit from the pullbox or junction box to the rail. Band conduit to concrete tie. Epoxy bolts to the concrete invert. Conduit shall be sealed immediately after installation of bond strand wire.
 - 2. Bond strand connections shall be exothermically welded to the neutral axis of the rail and within 6 inches of the insulated joint bar. Provide sufficient slack in bond strand at termination points to allow for minor rail movement and for a minimum of 3 re-terminations without having to replace or re-run the wire. Slack for re-terminations shall be kept in rail clips that are designed to attach to the rail without drilling.
 - 3. Plug bonds shall not be used.
- B. Track Circuit Connections
 - 1. Install track circuit connections as close to insulated joint location as possible.
- C. Test: Test track circuits in accordance with the requirements of SECTION 34 42 76 – Signals Tests And Inspections.

3.3 SPECIAL TRACKWORK POWER BONDING

A. General

1. Bond connections shall be made using approved exothermic weld techniques and materials that provide a thorough mechanical connection and electrical contact. Welding shall be performed in accordance with the bond manufacturer's recommendations and in accordance with Contract Drawing Typical Installation Drawings.
2. Conduit used for the installation of bonding cables shall be immediately resealed with an approved resilient sealing compound made expressly for the purpose.

B. Embedded Track

1. The Contractor shall be responsible to furnish, install, and test all power bonding.

3.4 CROSSBONDS

A. Locations: Coordinate the locations of crossbonds with AGENCY prior to installation.

B. Crossbond Cable

1. In non-signaled territory, cut cable to appropriate lengths, install and weld directly to the rail or plate, as indicated on the Contract Drawings.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

A. The quantities of accepted work will be measured in the following units. All measurements will be plan measure except for authorized changes.

1. Description: Lump Sum

4.2 PAYMENT

A. Payment will be made at the respective unit or lump-sum price listed in the proposal and shall be full compensation for all labor, materials, and equipment necessary to complete the respective unit in place. There will be no separate measurement or payment for any item of work not specifically identified and listed in the proposal, and all such work shall be considered a subsidiary item with all costs pertaining thereto included in the prices for other items listed in the proposal. At the Engineer's option, partial payment may be made for any lump sum item listed in the proposal, providing that the Contractor is diligently and satisfactorily pursuing full completion of such partially complete item in accordance with the approved job progress schedule.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 34 42 60**SIGNALS TRAIN-TO-WAYSIDE COMMUNICATIONS****PART 1 - GENERAL****1.1 SUMMARY**

- A. This Section includes the requirements for furnishing and installing the Train-to-Wayside Communications (TWC) System.

1.2 RELATED SECTIONS

- A. SECTION 01 33 00 – Submittal Procedures
- B. SECTION 01 43 00 – Systems Quality Assurance
- C. SECTION 34 42 10 – Signals General Engineering and Design Requirements
- D. SECTION 34 42 16 – Signals Wire and Cable
- E. SECTION 34 42 40 – Signals Tags, Locks, and Keys
- F. SECTION 34 42 76 – Signals Test and Inspections

1.3 SUBMITTALS

- A. Unless otherwise specified, all submittals shall be in accordance with SECTION 01 33 00 – Submittal Procedures and SECTION 34 42 10 – Signals General Engineering And Design Requirements.
- B. TWC Product Data: Submit TWC product data, including interrogator, filter, tuning kit, encapsulation kit, and all printed circuit boards. Include product material specifications, drawings and parts lists. Include proposed paint for the wayside loops.
- C. TWC Cable: Submit TWC cable in accordance with the requirements of SECTION 34 42 16 – Signals Wire And Cable.
- D. TWC Installation Drawings: Submit an installation drawing for each type of loop (e.g., ballast, embedded). Include loop layout, mounting material and methods (e.g. epoxy filler for embedded loops), pullbox or junction box location, and other associated equipment and conditions necessary to completely identify the installation. Refer to SECTION 01 33 00 – Submittal Procedures, for additional requirements.
- E. TWC Programming Software: Submit three sets of software for the programming of the decoder card. Include instructions for programming and the proposed destination assignment scheme.
- F. TWC Programmer's Resume: Submit a resume for the proposed engineer to perform TWC programming.

1.4 QUALITY ASSURANCE

- A. The Contractor shall comply with requirements of Division 1.

PART 2 - PRODUCTS**2.1 DESIGN REQUIREMENTS**

- A. The Signal System shall use the Train-to-Wayside Communications System to provide control of select interlocking routes from on-board the Street Car. The system provided shall be HSC-R system, supplied by Hanning & Kahl, or owner approved equal. Contractor to verify required TWC equipment with the carborne TWC supplied equipment. Contractor shall also coordinate with traffic signal operation during the desing of the signal system
- B. The interface to the vital microprocessor shall be coordinated to address the physical, electrical, and message protocol requirements.
- C. The unit shall communicate at 9600 bps, which shall be the default setting in the case of a loss of communications.

2.2 WAYSIDE EQUIPMENT

- A. Interrogator
 - 1. Provide each interrogator unit capable of controlling for up to four wayside loops. The interrogator unit shall be complete with all cards and devices necessary for system operation, and shall include, but is not limited to:
 - a. Power supply;
 - b. Transmitter/receiver;
 - c. Register;
 - d. Application backplane;
 - e. Programmable decoder, and;
 - f. Relay interface.
 - 2. The latest version of the programmable decoder card shall be utilized within the interrogator. Each card shall be programmed to perform all the functions required for its application at the respective location. The programming of each unit shall be recorded.
 - 3. A relay interface card, installed in the application backplane, shall be used for the interface between the programmable decoder card and the vital microprocessor.
 - 4. With all required cards installed, the application backplane shall have two spare slots available.
 - 5. At a minimum, whether used or not, the unit shall include:
 - a. Provisions for interfacing to 8 form 1C contact closures, and;
 - b. Provisions for controlling 8 external relays.
- B. Loop
 - 1. Furnish and install wire loops between the rails, at the locations indicated on the Contract Drawings, to read information from the train.
 - 2. Backfill the sawcut made in the concrete to install the loop with an appropriate material.

3. Adjust the size and location of the loops in accordance with the manufacturer's recommendations.
 4. Provide the number of turns in loop cable in accordance with the manufacturer's recommendations.
- C. Cable
1. The type, size and characteristics of the cable between the interrogator location and the loop location shall be as recommended by the manufacturer for this application. It shall be suitable for installation in a systemwide ductbank in an electrified railroad environment.
 2. Furnish an install a compatible interface cable for interconnections between the interrogator and the vital signal microprocessor, per the requirement of SECTION 34 42 16 – Signals Wire And Cable.
 3. The Contractor shall submit the type of protocol and interface standard used. The protocol shall be an industry standard used in North America, and shall be compatible with other signal and communications systems functions.
- D. Support Equipment: Provide hardware, software, adjusting equipment, special tools, and test equipment for installation, adjustment, and testing of the TWC System. Provide required connecting cables and/or interfaces for use with the laptop computer described in SECTION 34 42 72 – Signals Spare Parts, Manuals, And Training. Software shall function properly on the personal computer specified. Provide an additional copy of the software for backup and installation on the Vehicle maintenance laptop computers.
- E. Power: Furnish and install necessary power supplies.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Operation: Provide a system that meets the operational requirements specified in SECTION 34 42 68 – Signals Circuit and Operational Requirements, and as indicated in the Contract Drawings.
- B. Function: The TWC System will permit the following capabilities:
1. Automatic routing of trains at select interlockings, based on train destination.
 2. Selectable routing to a specific track at select interlockings.
 3. The ability to cancel a selected route and request an alternate or the same route as desired.
- C. Route Control
1. TWC shall be provided at locations where route selection is required, as indicated on the Contract Drawings. At these locations, the interrogator will interface with the signal microprocessors (e.g., route requests). Provide for the following routing functions:
 - a. Primary Route.
 - b. Secondary/Storage Route.
 - c. Route/Crossing Cancel.

- D. Destination Routing
 - 1. The design shall permit the routing of trains based on destination settings on the vehicles. The design shall permit future extensions of the system.
- E. Programming
 - 1. Program the system so that in the event of a system power failure, once power has been restored, the system maintains the proper data rate to communicate with the vital microprocessor.
 - 2. Programming shall be performed by someone who has had experience in doing so, preferably by the manufacturer's representative. Submit, to the satisfaction of the Resident Engineer, the qualifications of the person who will be performing the programming.

3.2 INSTALLATION

- A. General: Install equipment in accordance with the manufacturer's recommendations and requirements, and as specified in these technical specifications.
- B. Clearance Requirements: The design and installation of the equipment shall not interfere with the dynamic clearance of the vehicle.
- C. Security: Provide locks and/or other security in accordance with the requirements of Section 34 42 40 – TAGS, LOCK, AND KEYS.
- D. Wayside Loops
 - 1. The loop wire shall be installed in the concrete with a saw cut.
 - 2. After installation of the wire loop, seal over wire with an approved waterproof epoxy filler or sealant that does not impede reception of signals from the vehicle.
- E. Filter Unit
 - 1. Each loop shall be tuned according to the manufacturer's directions and recommendations. Loop operation shall be tested to confirm proper system operation before sealing the filter units. Sealing of the units shall be in accordance with the manufacturer's specifications or recommendations using approved encapsulation kits.
 - 2. In embedded areas, install a junction box in the pullbox provided by the facilities contractor adjacent the blockout, and install the filter in the junction box.
 - 3. The wire from the loop to the filter unit shall be twisted and no longer than permitted by the manufacturer.
- F. Interrogator
 - 1. The interrogator shall be properly mounted in the relay case. It shall be located so that the cards are easily accessible for testing or replacement by maintenance personnel.
 - 2. Wiring and connections for power and interfaces to the interrogator shall be according to the manufacturer's instructions.
- G. Cable Terminations: Install and terminate signal cables entering the relay case in accordance with the requirements of SECTION 34 42 16 – Signals Wire and Cable.

- H. Test: Test the TWC System in accordance with the requirements of SECTION 34 42 76 – Signals Tests and Inspections.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

- A. The quantities of accepted work will be measured in the following units. All measurements will be plan measure except for authorized changes.

1. Description: Lump Sum

4.2 PAYMENT

- A. Payment will be made at the respective unit or lump-sum price listed in the proposal and shall be full compensation for all labor, materials, and equipment necessary to complete the respective unit in place. There will be no separate measurement or payment for any item of work not specifically identified and listed in the proposal, and all such work shall be considered a subsidiary item with all costs pertaining thereto included in the prices for other items listed in the proposal. At the Engineer's option, partial payment may be made for any lump sum item listed in the proposal, providing that the Contractor is diligently and satisfactorily pursuing full completion of such partially complete item in accordance with the approved job progress schedule.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 34 42 68**SIGNALS CIRCUIT AND OPERATIONAL REQUIREMENTS****PART 1 - GENERAL****1.1 SUMMARY**

- A. This Section includes:
 - 1. Requirements pertaining to operation of the signaling system.
 - 2. Requirements for the design of specific vital and non-vital circuits.
 - 3. Site-specific operating requirements for each location that shall supplement the requirements of the Contract Drawing Route and Aspect Charts.

1.2 RELATED SECTIONS

- A. SECTION 01 33 00 – Submittal Procedures.
- B. SECTION 01 43 00 – Systems Quality Assurance.
- C. SECTION 34 42 25 – Signals Relays and Plugboards
- D. SECTION 34 42 76 – Signals Tests and Inspections

1.3 REFERENCES

- A. American Railway Engineering and Maintenance-of-Way Association, Communications & Signals Manual of Recommended Practice [AREMA C&S Manual]
 - 1. AREMA C&S Manual, Part 2.2.10 – Recommended Functional/Operating Guidelines for Interlockings.
 - 2. AREMA C&S Manual, Part 11.2.1 – Recommended General Practices for Electrical Surge Protection of Signal Systems.
- B. Federal Railroad Administration [FRA]
 - 1. FRA 236 – Rules, Standards, and Instruction Governing the Installation, Inspection, Maintenance, and Repair of Signal and Train Control Systems, Devices, and Applications.

1.4 QUALITY ASSURANCE

- A. The Contractor shall comply with the requirements of Division 1. The Contractor shall also conduct tests for all wayside signal equipment in accordance with SECTION 34 42 76 – Signals Tests And Inspections.

1.5 SUBMITTALS

- A. Unless otherwise specified, all submittals shall be in accordance with SECTION 01 33 00 – Submittal Procedures and SECTION 34 42 10 – Signals General Engineering and Design Requirements.

- B. Circuits: Submittal of circuits and signal software equations shall be part of the Book of Plans submitted for each relay case as specified in SECTION 01 33 00 – Submittal Procedures.
- C. Preliminary Operational Description: Submit a complete operational description of each interlocking using the descriptions included herein as a basis. Include descriptions for all routes. Submit concurrently with the Preliminary Track Plans, as specified in SECTION 01 33 00 – Submittal Procedures.
- D. Final Operational Description: Submit an updated operational description of each interlocking after System Integration testing has been completed. Identify final time delay settings.

PART 2 - PRODUCTS

2.1 OPERATIONAL DESCRIPTION

- A. Interlocking Descriptions: Using the operational descriptions included in Article 3.01 herein, in combination with the requirements of the Contract Drawing Route and Aspect Charts, provide a complete operational description for each interlocking, including manual crossovers. Expand the descriptions and fully describe how the signal system will operate. Include, at a minimum:
 - 1. Normal operating scenarios
 - 2. Reverse running scenarios
 - 3. Crossover moves
 - 4. All modes of route initiation and cancellation, including:
 - a. Local Control Panel (LCP)
 - b. Train-to-Wayside Communications (TWC)
 - 5. Signal aspects
 - 6. Time release settings: Identify the time release setting provided for each crossing activation point and each signal apparatus, including all approach and/or time locking settings.

PART 3 - EXECUTION

3.1 OPERATIONAL DESCRIPTIONS

- A. General Operating Requirements
 - 1. Under normal operating conditions, interlockings shall be controlled by a train stopping at the interlocking limits and making a TWC request for the desired route. Each interlocking shall be provided with a local control panel for use in the event of a TWC failure or for routine maintenance.
 - 2. Separation of trains in general will be performed through the use of train scheduling, with trains operating under “line of sight” rules, unless specified otherwise.
 - 3. Except at interlockings, train movement along the alignment will be regulated by the street traffic signal system and be “line-of-sight”.

4. The only "signalized" portion of the alignment shall be within interlocking limits. Movements through interlockings shall be governed by 3 aspect wayside signals. Standard railroad signal techniques shall be employed to control the home signals, line routes, lock switches, etc.
5. Contractor furnished and installed interlocking signals shall be placed at interlocking limits to provide the Street Car operator with a visual indication that a route through an interlocking is aligned and locked. Home signals shall be mounted on OCS poles adjacent to the right-of-way as close as possible to the interlocking limits.
6. No traffic circuits shall be provided between interlockings.
7. The signal system shall allow reverse movements through interlockings as indicated on the contract drawings.

3.2 GENERAL

- A. Microprocessor Logic: Although the requirements for the design of the signal system circuits described herein are based on relay-based functional descriptions, the Contractor provide a vital microprocessor-based approach to the design of the Signal System, which shall conform to the AREMA C&S Manual, Parts 2.2.12, Recommended Functional/Operational Guidelines for Vital Software-Based Interlocking Systems unless specified or approved otherwise. The intent of the specification is to eliminate the use of both vital and non-vital relays, to the maximum extent possible, through the use of microprocessors. The Contractor is encouraged to submit solid state alternatives to functions which would be normally be handled by relays, such as light out detection, switch control, etc. for approval. The Contractor shall depict microprocessor-based logic in standard relay logic format or ladder logic depending on the format used for its development.
- B. Fail-Safe: Provide fail-safe circuit design and equipment, unless specified otherwise. Vital circuits shall be of fail-safe design, based on closed loop circuit principles, and meet AREMA requirements for the use of vital relays.
- C. Spare Contacts: Where relays are utilized, design circuits to provide a minimum of one independent front-back contact on the first relay of that function, or on the last series repeater of that function.
- D. Electrical Surge Suppression: System shall be protected against lightning and other voltage surges in rail and power supply leads when installed in conjunction with external surge protection, conforming to AREMA C&S Manual, Part 11.2.1, Recommended General Practices for Electrical Surge Protection of Signal Systems.

3.3 VITAL CIRCUITS

- A. General: All vital circuits that energize a relay located outside of a relay case and all circuits which energize a vital relay located inside a case but which contain contacts outside of the relay case, shall be two-wire double break circuits, energized from an ungrounded DC power supply.
- B. Relays: Construct vital circuits using vital relays, vital relay timers and other vital components. Non-vital components shall not be placed in vital circuitry.
- C. Repeater Relays: Provide repeater relays as necessary to meet design needs and spare contact requirements. Provide series repeater circuits for vital circuits. Establish guidelines for use of primary and repeater relay contacts, based on system safety requirements, and to minimize the impact to system operation should a repeater relay fail to operate in conjunction with its primary relay.

- D. Vital Functions: Vital circuits shall include:
1. Route security and check circuits
 2. Switch locking circuits
 3. Switch correspondence circuits
 4. Switch repeater circuits
 5. Loss of shunt (OS track)
 6. Detector locking
 7. Train detection
 8. Switch operating circuits
 9. Signal lighting circuits
 10. Signal clearing circuits
 11. Time locking circuits
 12. Track repeater circuits
 13. Line circuits, where applicable
 14. Track circuits

3.4 NON-VITAL CIRCUITS

- A. Positive Energy: Provide positive-energy single break type non-vital relay circuits.
- B. Repeater Relays: Provide series or parallel repeaters of non-vital relays.
- C. Non-Vital Functions: Non-vital circuits shall include, as a minimum, the following:
1. Switch request logic to request alignment of individual switches in response to action by TWC or the LCP.
 2. Signal control request circuits to request and cancel signal clearing. Control this circuit from TWC or by the LCP.
 3. Local manual control panel circuits to facilitate transfer of control and to provide LCP lighting.
 4. Provide route request logic to request or cancel signals for those locations indicated in the Contract Drawings, in response to LCP or TWC activation.
 5. Power On Indication.

3.5 CIRCUIT REQUIREMENTS

- A. Route Request Circuits: Route request circuits perform the functions required before acknowledging and processing signal clearing requests. Route request circuits shall:
1. Prevent signal clear request from being acted upon when conflicting routes are aligned.
 2. Provide cancel functions to cancel route request and signal clear request.

3. Provide non-vital type signal call circuits that request and cancel routes over switches.
4. Route request circuits will operate under hierarchical control. Local control shall have the highest priority followed by TWC. The normal mode of operation shall be via the TWC system. When placed in Local Control, the panel may override route requests made via TWC. Changing the mode of operation shall not in itself cancel a request made in another mode of operation.
5. Provide a signal fleeting function for normal direction moves for all locations. The fleeting column on the Contract Drawing Route and Aspect Charts indicate those signals fledged for normal operation. Fleeting is the type of control in which route selections are automatically re-established after the passage of trains, thereby permitting continuous system operation without requiring LCP intervention to align routes.
6. Route initiation and cancellation shall be capable via:
 - a. Train to Wayside Communications (TWC) System.
 - 1) Provide route request circuits to interface TWC requests to the switch request, signal clearing, and cancel request circuitry for those locations and routes indicated.
 - 2) The TWC request shall not process switch position requests or signal clearing unless all conditions necessary for the clearing of that route are available. The system shall store the request until conditions allow its execution.
 - 3) The circuitry shall remember the TWC request until the route is cleared or cancelled by a subsequent request. The TWC system shall allow a train operator to re-request the same route after it has been cancelled.
 - 4) TWC requested moves through interlockings shall normally be requested by destination numbers programmed into the TWC unit. The train operator shall also have the ability to request individual switches and signals.
 - b. Local Control Panel (LCP) – The local control panel described below is based on a standard panel with physical levers, pushbuttons, and lights and is intended to be used only as a general description of how the LCP shall function. The Contractor shall furnish a PC based LCP with an LCD display. The display shall be the largest one that will mount in the relay case. At a minimum the local control panel shall provide the following features;
 - 1) Be PC based and communicate serially with the signal system microprocessor for the status of wayside equipment such as switches, track occupancy, signal aspects, etc.
 - 2) Communications parameters between the local control panel and the signal system microprocessor such as baud rate shall be adjustable with a default function to automatically return them to factory settings.
 - 3) Have the ability to monitor and decode the serial messages being sent between the local control panel PC and the signal system microprocessor.

- 4) Have a "Link Health" monitor that automatically shows the status of the serial link (OK or failed) between the local control panel PC and the signal microprocessor.
 - 5) Have the ability to display alarm indications such as ground faults, power off, burned out signal bulb, etc on the local control panel.
 - 6) The colors, line weights, and text fonts shall be adjustable. For example, a track section shall be able to change both, its color and line weight based upon occupancy, route lined, etc. Switches shall be able to change color based upon locked/unlocked, blocked, etc. Signals shall change colors based upon, clear, at stop, fleeted, blocked, etc.
 - 7) Signal indications on the panel shall match the indication of the signal in the field. A flashing aspect in the field shall be displayed as flashing on the local control panel.
- c. The proposed equipment as well as the actual proposed display shall be submitted for approval prior to fabricating the panel. The colors, line weights, and fonts used to depict the objects and conditions shown on the panel such as switches, signals, track segments, etc. will be selected by the Agency as a part of the approval of this submittal. The final local control panel display will then be created using these selections as a basis for the objects and text shown on the panel. As a part of this submittal the Contractor shall provide a written description of the differences between what is described below and how the actual panel will function. Operation of the LCP shall follow standard "unit-lever" type operation.
- 1) The panel shall provide all required controls and indications to support unit lever operation. To establish a route when in MANUAL (Local) operation, the LCP operator switches shall first aligned to the desired route with the switch levers. Switch position indicators on the local control panel shall flash in the direction requested until the switch points indicated correspondence with the request.
 - 2) Once the route is aligned, the track sections shall create a white line through the interlocking limits. The LCP operator shall next request the desired signal by pressing the appropriate signal request pushbutton. All signals shall also be equipped with signal cancel pushbuttons. Signals for moves in the "normal" direction shall also be equipped with fleeting pushbuttons.
 - 3) When the signal clears, the appropriate signal indication will illuminate and the route through the interlocking shall turn to green. As the Street Car moves through the route, the green light shall change to red to indicate occupied track circuits. If the operator wants to fleet a signal he will first clear it and then the push the "fleet" pushbutton. In order to cancel a fleeted signal the operator will use the signal cancel pushbutton. A signal that is "in-time" shall flash red.
 - 4) Provide lamp-out indications for each signal.
 - 5) As the Street Car clears each track circuit, the indication shall return to dark.

- 6) To cancel a signal, the cancel pushbutton shall be operated for the designated signal.
 - 7) Provide auxiliary switch control levers to operate the switches independently without setting up a route.
 - 8) Provide a "key-switch" that must be operated in order to assume control of the interlocking via the LCP.
- B. Switch Lock Circuits: Provide one vital switch locking circuit for each powered switch turnout or switch correspondence group. Switch lock circuits shall include detector locking, approach and/or time locking (as applicable), and loss of shunt protection. Switch locking shall only be released when approach locking, time locking, and route locking are released, and detector track circuits are unoccupied.
- C. Switch Control Circuits: Provide one vital normal and one vital reverse control relay wired in parallel for opposite polarities.
1. Provide three-wire, double-break, polar circuit for the switch operating relay network.
 2. Control operation of the switch machine by opening, closing, and reversing polarity to motor windings via contacts of the switch control relays. Provide a magnetic blow-out feature with these contacts. If the switch operating relay is not the same manufacturer of the switch machine, Contractor shall submit evidence that the contact ratings are applicable for the switch machine.
 3. Check front contacts of the switch control relay against the control relay for the opposite switch position. If both switch control relays are de-energized or both are energized, do not apply power to switch machine motor.
 4. Provide overload stick relays to remove power from the switch machine if the operating current rises to the level and duration to which the friction clutch is adjusted. Wire one coil of the overload stick relay in series with the switch operating circuit to energize the overload stick relay if an overcurrent condition occurs; use of an external nichrome wire is acceptable. Energize the other coil of the overload stick relay located in the switch control circuit so that overload stick relay remains energized until switch call is removed or reversed. Energizing the overload stick relay will de-energize the switch control relays of the switch machine. The overload relay shall energize in accordance with the requirements of the switch machine manufacturer.
- D. Switch Correspondence Circuit: Provide vital switch correspondence circuits to indicate agreement between physical switch position and switch call.
1. Provide one normal and one reverse switch correspondence relay for each switch or pair of switches that work together (crossover).
 2. Energize switch correspondence relays using a biased-neutral relay, controlled by two-wire, double-break, polar circuit. Correct polarity energy for energizing the correspondence relay shall appear across relay coils when both the switch machine and switch point detector circuit controllers indicate that switch is mechanically locked in the desired position. Verify that the opposite switch call relays and opposite switch correspondence relays are de-energized. Provide a combination switch correspondence relay for switch pairs when necessary to verify that the position of both switches are in agreement before requesting a route over the interlocking.

3. Lock the switch in the normal or reverse position before the associated switch correspondence relay will energize. Wire the circuit so that the position of the switch machine can be checked at the relay case, and switch junction box, to facilitate maintenance.
 4. De-energize the correspondence relays when the hand crank is inserted for manual operation or when the selector lever is moved from the power position to the hand position.
- E. Solid State Alternative: The intent of the specification is to eliminate the use of relays to the maximum extent possible. As an alternative the Contractor is encouraged to submit for approval an alternative solid state device which will provide switch control, indication, and overload functions. The intent of the specification is that the proposed device shall provide all of the functionality described above without the use of vital relays.
- F. Route Check Circuits: Provide route check circuits to initiate signal clearing, or provide an input to the street traffic controller, for each controlling interlocking signal.
1. Energize vital route check relays to initiate wayside signal clearing when conditions required for the route are verified:
 2. Verify that no conflicting conditions exist in the interlocking.
 3. Verify that switch positions are correct by using switch correspondence relays.
- G. Approach Locking Circuits: Provide an approach locking relay for each signal, where applicable.
1. Approach locking shall lock switches within a route governed by a cleared interlocking signal and shall prevent opposing or conflicting routes.
 2. Approach locking for an interlocking signal shall lock movement of switches when that signal is cleared by the route check relay. Approach locking circuits shall prevent simultaneous clearing of conflicting signals within interlocking.
 3. Release approach locking when approach locking relay is energized. Release approach locking for signals when one of the following has occurred:
 - a. Street Car passes signal and the signal goes to STOP. Include the POS in the circuit.
 - b. Signal is set to STOP and time locking has been released.
- H. Time Locking: Prevents the position of a switch from being changed until a pre-determined time has elapsed after a signal governing movements over the route has been caused to display a stop aspect. Provide, in accordance with AREMA guidelines, for all routes not having approach locking. Initially set timers for 30 seconds.
- I. Route Locking: Prevents the movement of any switch on a cleared route in advance of a train. Provide in accordance with AREMA guidelines.
1. Route locking shall be effective when a train passes a signal displaying an aspect for the train to proceed.
 2. Release route locking when route locking relays are energized.
 3. Release route locking when a train has passed the interlocking signal, approach or time locking has been released, and track circuits within the route have become unoccupied.

4. Where sectional release of route locking is required, release each section independently as it becomes unoccupied.
 5. Release route locking when approach or time locking releases after interlocking signal has been set to STOP.
- J. Signal Clearing Circuits: Signal clearing circuits shall verify that:
1. Route check circuit indicates route has been established.
 2. Approach locking for interlocking signal is in effect.
 3. Approach or time locking for opposing signals is not in effect.
 4. Switches within the route correspond with their calls and are mechanically and electrically locked.
 5. No conflicting routes are being processed.
 6. Appropriate interlocking track circuits are unoccupied.
 7. No residual time is left on approach locking timer.
- K. Signal Lighting Circuits and Aspects: Provide vital signal lighting circuits for each signal using a direct output from the vital microprocessor. Signal lighting shall be configured such that:
1. A horizontal aspect is illuminated for a signal set to STOP.
 2. A steady 45° aspect is illuminated for a signal set to CLEAR with the switch points reverse, normal direction of travel.
 3. A steady 90° aspect is illuminated for a signal set to CLEAR with the switch points normal, normal direction of travel.
 4. A flashing 45° aspect is illuminated for a signal set to CLEAR with the switch points reverse, reverse direction of travel.
 5. A flashing 90° aspect is illuminated for a signal set to CLEAR, with the switch points normal, reverse direction of travel.
 6. A dark aspect shall not create a condition to display a less restrictive aspect, and shall be interpreted as STOP.
- L. Line Circuits
1. Provide other line circuits, as required by the Contractor's final design, to provide line information not supported by the vital interlocking microprocessor.
 2. Information between locations may be transmitted via line wire to DC relays or may be coded information for microprocessor logic with requirements as follows:
 3. Relay Logic
 - a. Provide double break type line wire circuits using ungrounded energy to control vital bias neutral relays.
 - b. Provide a line resistor for each circuit.

- M. Event Recorder
 - 1. Record vital signal system functions, including, but not limited to:
 - a. Track circuit occupancy
 - b. Route locking
 - c. Approach locking
 - d. Time locking
 - e. Switch correspondence
 - f. Switch lock
 - g. Signal clear
 - h. Power On indication
 - i. Loss of shunt
 - 2. Record all alarms.
 - 3. Time stamp all events.

3.6 APPLICATION

- A. General: Design and install the circuits described above in a manner that provides a complete and functional system, meeting all the requirements of the Contract Documents.
- B. Safety
 - 1. Safety of operations for AGENCY's Street Car System is primarily the responsibility of operator adherence to AGENCY's operating rule-book. There is, however, no equipment on board the Street Car, such as overspeed protection, to enforce wayside signals. Whenever an unsafe condition could develop from an equipment failure or a procedural error, fail-safe design techniques shall be used to prevent the occurrence of the unsafe condition. All control methods, circuitry, mechanical equipment, solid-state apparatus, and operating procedures provided under this Project for vital operation shall conform to this requirement.
- C. Vital Circuits: The term vital, when used in these technical specifications, shall be used to mean any function, application, or technique whose purpose it is to maintain the safety of life and property.
- D. Fail-Safe, General: As used in these technical specifications, the fail-safe principle shall mean that whenever an equipment failure, a human error or a failure to act, or an adverse environmental condition affects the specified operation of a system involved with the safety of life or property, that system shall revert to a state known to be safe. The following shall apply to all circuit design:
 - 1. The failure of a circuit or of equipment, which results in an indication of a dangerous or restrictive condition, whether or not there is in fact actual danger, shall have met the fail-safe requirement of these technical specifications. Conversely, a failure which results in an indication of safe or of a less restrictive condition when a dangerous condition exists shall not have met the fail-safe requirements.

2. The failure of any of the vital Signal System components shall not in any way affect the safety of train operation. System design shall include means of protecting the equipment from malfunction or damage due to voltage transients on or induced in the wiring. The equipment shall also be protected from damage from accidental overvoltage or voltage reversal, and be immune to the existing or possible extraneous frequencies or energy which may be present.
 3. The Signal System shall be based on principles that shall permit the attainment of fail-safe operation in all known or discovered failure modes.
 4. Fail-safe circuits shall employ the closed loop principle and shall protect against open circuits, shorted circuits, grounded circuits, or any combination of these.
 5. All line circuits, which control vital functions, shall be two-wire, double-break circuits. All circuits of a vital nature shall be energized from ungrounded power supplies.
 - a. In addition to any other power supplies required by the Contractor's design, the Contractor shall provide a separate LB (Line Battery) supply. This power supply shall be used exclusively to supply DC power to loads outside of the signal case other than signal bulbs. Such loads shall include but not be limited to;
 - 1) Switch indication circuits
 - 2) Control and Indication circuits for electric locks
 - 3) Line circuits
 6. Relays used in vital circuits shall be "vital" as specified herein.
 7. Spurious oscillations from any electronic equipment or component thereof, whether passive or active, shall not cause an unsafe condition.
 8. Filters used in fail-safe circuits shall be designed to prevent undesired signals, of a level which could cause an unsafe condition, from appearing at the filter output.
 9. All vital signal relays, filters, modules, and other components shall not have an operating frequency within the harmonic spectrum of the DC traction power transformer/rectifier harmonic output.
- E. Fail-Safe, Circuit Design: In producing a fail-safe design, consider the following and other possible equipment failures and conditions:
1. Vital Relays: Open coils, shorted coils, or high contact resistance.
 2. Non-vital Relays: Open coils, shorted coils, fused contacts, high contact resistance, armature sticking, and broken springs.
 3. Transformers: Open primary, open secondary, shorted turns, primary to secondary shorts, or combinations of these conditions:
 4. Resistors: Increase in resistance or decrease in resistance.
 5. Capacitors: Shorted, open, or electrolyte leakage.
 6. Transistors: Shorted, open, leakage, or a loss of Beta.
 7. Diodes: Shorts, opens, or reverse leakage.
 8. Coils: Open or shorted turns.

9. The loss or degradation of power sources.
 10. The effects of electrical interference.
 11. Presence of abnormal signal levels, electrical noise levels, frequencies and delays in any electronic equipment.
 12. The absence of or abnormal input signals.
 13. Opens or shorts in internal circuitry.
 14. Drift or instability of amplifiers, receivers, transmitters, oscillators, switching circuits, and power supplies.
 15. Mechanical shock or vibrations.
 16. The deterioration of contacts, connectors, solder connections, terminals, printed circuits, circuit adjusting devices, and mechanical devices.
 17. Consider and minimize, in producing a design, the possibility of unsafe failures arising from procedural error and neglect, including:
 18. The careless adjustment of equipment and controls.
 19. The removal of components and/or assemblies.
 20. The incorrect assembly of equipment.
 21. Insufficient maintenance in all categories.
- F. Loss of Shunt: Arrange interlocking circuitry so a momentary loss of shunt does not cause release of the following circuits:
1. Route locking
 2. Detector locking
 3. Signal clearing
 4. Approach locking, where applicable
- G. Timers: Provisions shall be made in the design to adjust all functions requiring adjustable timers (e.g., approach stick timer) without changing program software. Install timers external to the processors if necessary. Timers shall meet the requirements of SECTION 34 42 25 – Signals Relays and Plugboards.

PART 4 - MEASUREMENT AND PAYMENT**4.1 MEASUREMENT**

A. The quantities of accepted work will be measured in the following units. All measurements will be plan measure except for authorized changes.

1. Description: Lump Sum

4.2 PAYMENT

A. Payment will be made at the respective unit or lump-sum price listed in the proposal and shall be full compensation for all labor, materials, and equipment necessary to complete the respective unit in place. There will be no separate measurement or payment for any item of work not specifically identified and listed in the proposal, and all such work shall be considered a subsidiary item with all costs pertaining thereto included in the prices for other items listed in the proposal. At the Engineer's option, partial payment may be made for any lump sum item listed in the proposal, providing that the Contractor is diligently and satisfactorily pursuing full completion of such partially complete item in accordance with the approved job progress schedule.

END OF SECTION

SECTION 34 42 72**SIGNALS SPARE PARTS, MANUALS AND TRAINING****PART 1 - GENERAL****1.1 SUMMARY**

- A. This Section includes the requirements for spare parts, manuals and training for the Signal System to be bid as part of this Contract.

1.2 RELATED SECTIONS

- A. SECTION 01 33 00 – Submittal Procedures
- B. SECTION 01 43 00 – Systems Quality Assurance
- C. SECTION 34 42 10 – Signals General Engineering and Design Requirements

1.3 SUBMITTALS

- A. Unless otherwise specified, all submittals shall be in accordance with SECTION 01 33 00 – Submittal Procedures and SECTION 34 42 10 – Signals General Engineering And Design Requirements.
 - 1. The Contractor shall submit Instructors Training Guides for proposed signal training classes.
 - 2. The Contractor shall submit a list of equipment manuals to be provided.
 - 3. The Contractor shall submit a list of recommended special tools, gauges, and test equipment.
 - 4. The Contractor shall submit a list of printed circuit boards used on the project.
 - 5. The Contractor shall submit a Recommended Spare Parts List.
 - 6. The Contractor shall submit a training schedule and curriculum.

1.4 QUALITY ASSURANCE

- A. The Contractor shall comply with the requirements of Division 1.

PART 2 - PRODUCTS**2.1 SPARE TOOLS AND PARTS**

- A. Special Tools – The Contractor shall furnish all special tools, gauges, and test equipment needed to maintain signal system equipment. The Contractor shall compile and submit a list of recommended special tools, gauges, and test equipment. The agency will review the list for completeness and approve it. The Contractor shall then furnish all of the items on the list as a part of the contract.

- B. Mandatory Spare Parts – The following items shall be supplied to the Agency as spare parts.

Item	Description	Quantity
	Each type of non-vital relay used as a part of the Contract.	10
	Two complete portable Train-to-Wayside Communications (TWC) test interrogators, transponders, and two 100kHz radios. This equipment is used to: Simulate a train to input a digital message to the TWC loop to determine that the TWC equipment can properly receive and decode a message Determine that the equipment is correctly transmitting a message to the train.	
	Each size and type of power supply used as a part of the Contract.	2
	Each type of vital relay used as a part of the Contract.	2
	Filter-V for Vetag TWC Equipment	10
	Communications Card W/O modem PDCC7	2
	H&K Interrogator	3
	Rail Web heaters of the same type furnished for the Contract sufficient to equip a #6 turnout.	2 sets
	Any fiber modems used on the Project.	2 of each type
	Laptop computer with trouble shooting and repair software	1
	Trouble shooting and repair software to be loaded on future computers	1

- C. Printed Circuit Boards – The Contractor shall compile a list of all of the circuit boards used in all of the electronic units furnished as a part of this Contract. These units shall include, but not be limited to, electronic track circuits, vital and non-vital microprocessor units, and TWC equipment. Based upon this list, the Contractor shall furnish 10% spare boards, with a minimum of two, for each type of board identified as being used as a part of this Contract.
- D. Recommended Spare Parts – In addition to printed circuit boards the Contractor shall compile a list of recommended spare parts that he feels are needed to adequately maintain the signal system.

2.2 PRODUCT MANUALS

- A. The Contractor shall furnish product manuals for each major item of equipment supplied as a part of this Contract including, but not limited to, switch machines, snow melters, vital and non-vital microprocessor systems, vital relays, track circuits, TWC equipment, and signals. These manuals shall deal with theory of operation, maintenance, troubleshooting, and replacement of defective parts with ordering references for each subsystem. The Contractor’s standard service manual shall be sufficient provided it covers the topics detailed above. The Contractor shall compile and submit a list of the manuals he proposes to furnish to meet this requirement to the Project Manager for Approval.
- B. The Contractor shall furnish a “master” copy as well as ten standard copies of each manual. The master copy shall be a standard manual that has been removed from its normal binding. Each page shall be laminated in heavy-duty plastic to protect it but allow copying on a standard Xerox copy machine. The individual pages shall be collected and assembled into a three ring binder with re-enforced holes.

2.3 TRAINING

- A. The Contractor shall provide training classes for the Agency Maintenance of Way (MOW) group. The Contractor can assume that the subject audience is conversant in basic electronics and troubleshooting techniques.
1. The training shall consist of 240 hours of training subdivided into six 40 hour courses. Training schedule and curriculum shall be submitted to the Agency for Approval.
 2. Each of the three classes shall consist of a maximum of ten the AGENCY personnel. In general, the students will be the AGENCY MOW personnel although occasionally the AGENCY Engineering may opt to audit a class.
 3. The training shall cover theory of operation, maintenance, and troubleshooting of major components of the signal system. These components shall include, but not be limited to, vital and non-vital microprocessors, TWC, local panel operation, power frequency track circuits, and switch heaters.
- B. As a part of the training class the Contractor shall create two manuals. These manuals shall be submitted for Approval prior to delivering the training to ensure that the content of the training classes is acceptable to the AGENCY.
1. The first manual shall be written as an instructor's guide. This manual shall be structured to lead the instructor through the training to be delivered. The intent is that by consulting the instructor's guide the AGENCY personnel will be able to deliver future training covering the same topics.
 2. The second manual shall be the student's guide. It shall be structured to re-enforce the training being delivered by the instructor. The manual shall be heavily illustrated with adequate space for the students to take notes on the pages that deal with the subject being covered. The Contractor shall provide adequate manuals so that each student has his own and the manual shall become the student's property when the training class is complete.
- C. Follow-up Training – If, after the training has been delivered, some basic element of the signal system design is changed by the Contractor, as determined by the AGENCY, a reasonable amount of additional training may be required. Such additional training shall be at no cost to the AGENCY.

PART 3 - EXECUTION

3.1 DELIVERY

- A. The Contractor shall deliver all spare parts to a location in the Kansas City area as directed by the AGENCY. Pack all material for warehouse storage and clearly mark with manufacturer's part and/or style number.
- B. The Contractor shall deliver master manual and ten standard manuals to the AGENCY maintenance as directed by the AGENCY.
- C. The Contractor shall unload and store all items neatly in the AGENCY-furnished storage facility as directed by the AGENCY.
- D. The Contractor shall complete delivery and storage for all spare parts no earlier than 30 days prior to, or no later than, the completion of system testing.

- E. The Contractor shall, at a minimum, supply one complete set of all special tools and test equipment necessary to service, repair, maintain and overhaul each system delivered for use in training program. At the completion of training program these special tools, test equipment and training aids shall be turned over to the AGENCY, in proper working order, by the Contractor.

3.2 WARRANTY USE

- A. In the event that provision items must be used in the course of satisfying Warranty procedures, Contractor shall replace such items within 30 days at no cost to the AGENCY.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

- A. The quantities of accepted work will be measured in the following units. All measurements will be plan measure except for authorized changes.
 - 1. Description: Lump Sum

4.2 PAYMENT

- A. Payment will be made at the respective unit or lump-sum price listed in the proposal and shall be full compensation for all labor, materials, and equipment necessary to complete the respective unit in place. There will be no separate measurement or payment for any item of work not specifically identified and listed in the proposal, and all such work shall be considered a subsidiary item with all costs pertaining thereto included in the prices for other items listed in the proposal. At the Engineer's option, partial payment may be made for any lump sum item listed in the proposal, providing that the Contractor is diligently and satisfactorily pursuing full completion of such partially complete item in accordance with the approved job progress schedule.

END OF SECTION

SECTION 34 42 76**SIGNALS TESTS AND INSPECTIONS****PART 1 - GENERAL****1.1 SUMMARY**

- A. This Section includes Specifications for tests and inspections to be performed at points of assembly and on the job site, and is intended to provide minimum requirements for testing. The Contractor shall organize a test program that verifies the adequacy of the signal system to meet all technical and performance requirements in an orderly and logical sequence.
- B. Tests and inspections shall be for the purpose of verifying design and nameplate ratings, ensuring proper performance and safety and demonstrating compliance with these Specifications.
- C. The Contractor shall inspect and functionally test each item to be delivered in accordance with the Contract Documents and Contract Drawings. Test procedures and inspections shall be conducted according to the manufacturers' standards except as otherwise specified, or Approved by the Agency.
- D. The Contractor shall conduct all tests in accordance with approved test procedures. Except as otherwise specified, the Contractor shall furnish all labor and materials necessary to perform tests, record data, and prepare reports. Tests shall demonstrate compliance with the requirements of these Specifications. All inspection and testing instructions shall provide for reporting non-conformance or questionable conditions to the Project Manager. Any changes required to bring the system into compliance shall be at no additional cost to the Agency, including the costs associated with the additional testing. After the completion of each test, the Contractor shall remove all test equipment and temporary facilities, and restore the system to full operational status.
- E. The Contractor shall permit the Project Manager, at his discretion, to participate in all inspections and to witness all tests, both at the manufacturers' plant and at the Site. Whether or not the Project Manager inspects or tests any materials or equipment, the Contractor shall not be relieved from any responsibility regarding defects or other failures to meet the Contract requirements nor shall such inspection or test be considered a guarantee of approval of any material or equipment, which may be delivered later for incorporation into the work. The Project Manager shall have access to all Work at the Site at any time during normal working hours. Except as otherwise agreed to by the Project Manager, inspections to be witnessed by the Project Manager shall be performed during normal business hours.
- F. The Contractor shall be responsible for the cost of all testing, whether conducted at his factory or on site.

1.2 RELATED SECTIONS

- A. SECTION 01 33 00 – Submittal Procedures
- B. SECTION 01 43 00 – System Quality Assurance
- C. SECTION 34 42 10 – Signals General Engineering and Design Requirements
- D. SECTION 34 42 25 – Signals Relays and Plugboards

- E. SECTION 34 42 44 – Signals Power Distribution
- F. SECTION 34 42 72 – Signals Spare Parts, Manuals, and Training

1.3 SUBMITTALS

- A. Unless otherwise specified, all submittals shall be in accordance with SECTION 01 33 00 – Submittal Procedures and SECTION 34 42 10 – Signals General Engineering and Design Requirements.
 - 1. The Contractor shall submit a Test Program Plan for Approval within 120 days subsequent to notice to proceed. This plan shall include a list of all factory and on-site tests to be performed, the approximate date, and location of each test.
 - 2. The Contractor shall submit test procedures for approval at least 30 days prior to implementation. Except where tests are to be performed in full accordance with published standards, each test plan shall include:
 - a. The definition of the purpose and objectives of the test
 - b. The description of the test to be performed
 - c. The definition and listing of prerequisites, which must be successfully completed prior to the start of the test -- including prior installation work, prior tests, and the prior review by the Project Manager
 - d. A list of equipment required for each test
 - e. A listing of the final test report documentation to be supplied to the Project Manager
 - f. A step-by-step test procedure
 - g. Blank test data sheet forms, with the range of acceptable test values pre-printed on each form.
 - 1) Except where results are recorded on a test data plate affixed to the component or unit, the Contractor shall submit certified test reports.
 - 2) The Contractor shall submit records of all field tests, giving procedures used and results.
 - 3) The Contractor shall submit for Approval reports of factory inspection procedures employed to ensure the quality of the product.
 - 4) the Agency reserves the right to witness and photograph, at its expense, any and all phases of equipment manufacturing, test, installation and construction, including subcontractor work, without restriction.

1.4 QUALITY ASSURANCE

- A. The Contractor shall comply with requirements of Division 1.
- B. The Contractor shall submit a list of instruments to be used for testing. The list shall include the manufacturer's name, model number, serial number, and calibration certificates for each instrument. The calibration certificate shall show that each instrument was calibrated by an independent agency within the previous 180 days. The Contractor shall not use items provided in SECTION 34 42 72 – Signals Spare Parts, Manuals, and Training to conduct the tests outlined in this Section. The Contractor shall implement tests and procedures as required in this Section.

PART 2 - PRODUCTS

2.1 TEST PROGRAM PLAN

- A. The Contractor shall develop and submit a Test Program Plan for the Signal System. The purpose of this plan is to ensure that the Contractor has considered all the testing requirements contained in this and other Sections of the Specification and has made adequate provisions for testing in his overall program plans and schedules; and to achieve an early mutual understanding between the Contractor and the Agency on range, depth and other aspects of tests to be conducted. The Program Test Plan shall contain, as a minimum, the following data:
 - 1. A flow diagram indicating the logical sequence of tests starting with factory assembly tests and concluding with system integration tests
 - 2. A list of test procedures (by test procedure number) to be submitted, preliminary submittal schedule, a preliminary schedule of tests, and a brief description of each factory and field test
 - 3. An outline and format of procedures and test data sheets for each type of test
 - 4. Requirements (if any) for the Agency-furnished material, personnel or equipment
 - 5. Requirements and recommendations for witnessing by the Agency personnel
 - 6. A description of the Contractor's in-plant and field test organizations
 - 7. Flow of Quality Assurance and field test data and use within the Contractor's Systems Engineering and Quality Assurance functions

2.2 FACTORY TESTS AND INSPECTIONS

- A. General
 - 1. All systems, subsystems and components forming an integral part of a failsafe circuit or subsystem shall be completely inspected and tested.
 - 2. All components or units, other than those related to failsafe circuits, may be tested on a sampling basis. An approved number of randomly selected components or units from the manufacturing process shall be tested to ensure the adequacy and acceptability of all components and units produced.
 - 3. Each component and unit shall be inspected at its point of manufacture and evidence of this inspection and acceptability shall be indicated on the item where practical.

4. The Contractor shall notify the Agency, in writing, a minimum of 1 week in advance of each test. When tests are to be conducted continuously as a production line routine, the Contractor shall inform the Agency in writing at least 2 weeks in advance of the date of commencing the tests and the expected duration. The Contractor shall notify the Corridor Project Manager 21 days in advance of tests of assembled relay cases that are undergoing final testing prior to being shipped to the field.
- B. All vital relays shall be factory-tested in accordance with AREMA Communications and Signals Manual, Parts 6.4.1 (Recommended Instructions for Direct-Current Relays), 6.4.5, (Recommended Instructions for Alternating Current Relays) and SECTION 34 42 25 – Signals Relays and Plugboards as applicable.
 - C. All wayside signal equipment including but not limited to signals, switch machines, switch point heaters, relays, and TWC equipment shall be inspected and tested prior to shipment.
 - D. All signal equipment shall be operationally tested and inspected as a complete functional assembly prior to shipment. Test each function by simulating operating conditions. Where equipment is related to a safety function, each component or subassembly shall be separately inspected and tested.
 - E. The Contractor shall perform tests and inspections needed to verify the system safety requirements.
 - F. Equipment functional tests shall be performed on the following equipment items. These tests shall be designed to show the proper operation of each major feature of each item. Certified test reports shall be submitted to the Agency before shipment showing the successful completion of each test.
 1. Switch machines
 2. Switch circuit controllers
 3. Signals
 4. Power converters
 5. Train-to-Wayside Communications (TWC) interrogators and wayside antennas
 6. TWC carborne equipment
 7. Switch heaters
 8. Vital relays
 9. Track circuits and track circuit equipment
 10. Local control panels
 11. Vital microprocessor interlocking equipment
 - G. Factory Wired Relay Racks/Cases
 1. Factory wired cases shall be tested as described below. For these tests, all cases and associated with a particular location shall be inter-connected so as to function as one unit. External equipment such as signals, switch machines, switch circuit controllers, and TWC interrogators and antennas shall be simulated and monitored during these tests. All relays shall be installed for this test.

- a. All factory wiring shall be continuity tested. The continuity test shall be done with a buzzer and appropriate battery. A continuity test using an ohmmeter will not be acceptable. During this test, all tagging shall be checked and verified. The set of plans used to wire the rack shall be used during this test. As each wire is tested it shall be "greened-off" the plans. When all wires on a page have been greened-off, the tester shall sign and date the page.
- b. A wire count shall be performed to verify that the number of wires that are connected to terminal posts, relay plug board receptacle springs and other termination points are in accordance with the approved circuit plans.
- c. All vital and non-vital wiring shall receive a complete circuit selection (breakdown) test. Each relay contact (separate openings for heel, front and back contacts) shall be opened, the appropriate relays shall be observed to drop, and the appropriate signal equipment shall be observed to respond as intended. The correct operation of each break point shall be noted on the plans with a check mark. When all breaks on a page have been checked-off, the tester shall sign and date the page.
- d. Operating tests shall be performed to verify that the factory wired equipment functions as intended.

H. Relays

1. Vital relays shall be factory tested to conform to the "shop" requirements of the AREMA Communications and Signals Manual Part 6.4.1 (Recommended Instructions for Direct-Current Relays) or Communications and Signals Part 6.4.5 (Recommended Instructions for Alternating-Current Relays). All relays shall be tested twice as described in SECTION 34 42 25 – Signals Relays and Plugboards. Test values shall be submitted to the Agency on standard FRA relay test data cards for reference.

I. Vital Microprocessor Interlocking Equipment Tests

1. The entire complement of cases for a given vital interlocking shall be set up at the point of assembly, with all equipment installed. The cases shall be interconnected with the same plug connector cables as will be shipped to the field, all in accordance with the accepted plans. The Contractor shall simulate functions external to the relay case, where required. All functions of the system shall be tested to determine that each function of the system operates as required.
2. The Contractor shall observe strict software version control during the testing. Prior to shipment, the Contractor shall correct all deficiencies identified during factory testing. The entire test procedure shall be passed successfully without making a change to the application software. If, at any point in the testing, it becomes necessary to modify the application software, at the discretion of the Project Manager, the test procedure shall begin again from the start.

2.3 CALIBRATION OF INSTRUMENTS

- A. All instruments or recorders employed in these test programs shall bear a record of calibration against certified standards. Such calibrations shall be made at least each 180 days and at such other periods as may be directed by the Agency. Each test record shall identify the specific instrument employed in the test and latest date on which it was calibrated.

2.4 FIELD TESTS AND INSPECTIONS

A. General

1. The Contractor shall perform all tests required to ensure proper and safe operation of all mainline equipment and prove the adequacy and acceptability of the total installation.
2. The tests to be performed shall cause each system and subsystem to be sequenced through all required operations and shall include simulated conditions to prove the installation is in compliance with failsafe requirements.
3. Prior to operational testing, the Contractor shall check the quality of installation by visual inspection and by tests of continuity, insulation resistance, and resistance of ground connections, vital circuit breakdown, and other tests as required.
4. The Agency shall receive written notification at least 48 hours prior to each test.
5. The Contractor shall check the dynamic outline clearance of all wayside installed signal equipment with a test train.

B. Prior to Installation and After Receipt on Site

1. All relays shall be inspected for shipping damage and tested to assure that pick-up and drop-away values and contact resistances agree with the "shop" values. Vital relays shall be tested to conform to the "shop" requirements of the AREMA Communications and Signals Manual Part 6.4.1 (Recommended Instructions for Direct-Current Relays) or AREMA Communications and Signals Manual Part 6.4.5 (Recommended Instructions for Alternating-Current Relays), and SECTION 34 42 25 – Signals Relays and Plugboards, as applicable. Non-vital relays shall be tested to conform to the non-vital relay manufacturer's specifications insofar as armature pick-up, armature drop-away, and contact resistance values are concerned. These tests shall be performed by a Relay Quality Control Inspector from the vital relay manufacturer who's normal and customary duties center on relay inspection. During this on-site relay test, the timing characteristics of all timing relays shall be checked and adjusted and the set values shall be recorded. The pickup and drop-away values for all vital relays shall be recorded on FRA relay cards AREMA Communications and Signals Manual Part 6.4.1 Form 641-1 (Recommended Office Record of Test of DC Electrical Apparatus) or AREMA Communications and Signals Manual Part 6.4.5 Form 645-1 (Recommended Office Record of Test of AC Electrical Apparatus) and submitted to the Agency. One FRA relay card shall be filled out for each vital relay. When testing is completed the relay cards shall be submitted to the Agency for their permanent record.

C. Wire, Cable Conductor and Shield

1. Each wire, cable and shield shall be individually checked with a ringer or buzzer to identify its two ends, the tagging checked for conformity with circuit plans, and the exact termination points (relay name and contact number, terminal number, equipment binding post, etc.) compared with that shown on the circuit plans. A check mark shall be applied to the installation copy of the circuit plans at each end of each wire tested at the time it is tested and found acceptable. This on-site test applies to all wires and cable conductors, however, point-to-point testing of rack and case wiring required by this Subsection, which was done at the factory, need not be repeated on-site provided the Contractor attests in writing that there have been no changes in the rack wiring after completion of the factory tests.

- D. Wire Count
1. A wire count shall be performed to verify that the number of wires connected to each terminal post, relay plug board receptacle spring and other termination point is in accordance with the accepted circuit plans.
- E. Megger Test
1. A 1000 Volt megger shall be used to determine insulation resistance of each underground cable conductor to ground and between conductors. A minimum of 5 Megohms between each conductor and ground and between each of the conductors is required. During this test, all associated signal equipment not under test shall be disconnected and terminals grounded. All electronic devices or signal equipment shall be disconnected or unplugged prior to any testing. All cable splices shall be completed. The test equipment manufacturer's instructions as to operation and electrical connections shall be followed. Test data and results shall be submitted to the Project Manager by the Contractor. The data shall be furnished in a form that complies with the FRA "Rules, Standards and Instructions for Railroad Signal Systems", CFR 49 Part 236.
- F. Breakdown Test
1. A complete circuit selection (breakdown) test of all relay cases and circuit controller wiring shall be performed. Each circuit shall, with the circuit energized, have each circuit break point (termination, front contact, back contact, heel contact, etc.) individually opened by hand to determine that the controlled device becomes de-energized with the circuit opened and re-energized when the test opening is re-closed. A check mark shall be applied to the installation copy of the circuit plans at each circuit break at the time it is determined that it is effective. During this test, line circuits to and from adjacent signal cases shall be connected and the adjacent signal cases shall be functional.
 2. This on-site test applies to all signal circuits, however, breakdown testing of case circuits required by this Subsection, which was done at the factory, need not be repeated on-site provided the Contractor attests in writing that there have been no changes in the case wiring after completion of the factory tests.
- G. Power Buss Test
1. With the system in working order, each energy buss shall be tested with a 500 Volt megger and shown to be at least 1 Megohm above ground. High voltage buses shall be de-energized when they are tested. At interlockings this test shall be performed with each possible route lined up.
- H. Power Supply Adjustment
1. The Contractor shall verify that each installed fuse is the correct type and amperage according to the circuit plans. Power supplies and rectifiers shall be set to the appropriate values. Voltages and transformer tap settings shall be recorded and noted on the as-built circuit plans.
- I. Timer Setting
1. Adjustable timers throughout the system shall be checked and adjusted and the set values shall be recorded and shown on the circuit plans.

- J. Lamp Voltage Adjustment
1. All lamp voltages (including signal and switch indicator and local control panel) shall be individually checked and adjusted. The tap settings and lamp voltage levels shall be recorded and submitted to the Agency.
- K. TWC Interrogator Test
1. All TWC interrogators shall be tested in accordance with its manufacturer's recommendations to assure that the TWC systems function as intended.
- L. Shunt Test
1. Checks shall be made to determine that the corresponding track relay drops when a 0.20-Ohm shunt is applied successively to each end and in the middle of each track circuit and at each end of all fouling circuits.
- M. Ground Test
1. Each ground network installation shall be tested to determine that a successful (15.0 Ohms, maximum) ground has been obtained and the values recorded.
- N. Power Switch Obstruction Test
1. Mainline power switches shall be checked to determine that:
 - a. Signal protection is provided when either switch point is in any position other than full normal or full reverse
 - b. A 1/4 inch gap, 6 inches from the point-of-switch, between either switch point and the stock rail causes the signal governing movements over the switch to display a "STOP" aspect, even if the switch points are locked
 - c. A 3/16 inch gap between either switch point and the stock rail does not cause the signal governing movements over the switch to display a "STOP" aspect
 2. Mainline power switches shall also be tested to assure that the latchout mechanisms, switch machine heaters, switch indicators, clutches and overload relays are all functioning properly. Normal and obstructed switch currents shall be measured and recorded. If necessary, the clutch shall be adjusted to bring the recorded values to within the manufacturer's recommendations. Tests shall be performed on both the normal and reverse points. All switch machines shall be checked to determine that the locking dog cannot enter the slot in the lock rod with a 1/4 inch obstruction gauge between the stock rail and the switch point.
- O. Switch Heater Test
1. Switch heaters shall be tested to ensure that they function properly.
- P. Local Control Panel Test
1. Local control panels shall be tested to ensure that they function properly including, but not limited to:
 - a. The ability to control all required functions
 - b. Properly display all indications

- Q. Event Recorder Test
1. Event recorders shall be tested to ensure that they function properly and provide the required 72 hours of recording capability.
- R. Power Distribution Test
1. Signal power converters, power transfer equipment, power distribution equipment and signal power conductors shall be tested to ensure that the system functions properly and as intended. As part of this test the spare capacity of the power system shall be calculated by the Contractor, using test data. The results of these calculations shall be submitted as a part of the power distribution calculations required in SECTION 34 42 44 – Signals Power Distribution.
- S. Signal Alignment Test
1. Signal alignment shall be checked and signals adjusted to provide maximum visibility. During this test, the light-out protection feature shall be checked for each signal so equipped.

2.5 ON-SITE OPERATIONAL TEST (CUTOVER)

- A. The final test prior to the Signal System Integration Test shall be the On-Site Operational Test (cutover). At this point all of the signal equipment shall be powered up and working with nothing being simulated except the movement of trains. The movement of trains shall be simulated by applying shunt wires to the track circuits and placing TWC test transponders over the appropriate TWC antennas. Tests shall be made to ensure all of the signal system functions work as intended. In addition to testing that all of the expected functions work as intended the test shall be structured so that functions that should be prevented from happening are in fact not allowed. Tests shall be made to determine, through direct observation that the appropriate signal aspects are displayed. During this test, line circuits to and from adjacent signal cases shall be connected and the adjacent signal cases shall be functional.
- B. All possible interlocking routes shall be set up and observations shall be made to determine that the correct signal aspects, for both conflicting and non-conflicting routes, are displayed and that detector, approach, indication, and route locking are effective. All combinations of route requests shall be tested. Tests shall ensure that all appropriate routes are granted.
- C. Test Forms
1. The test forms for this test shall be a step by step procedure that as a minimum lists:
 - a. The step number
 - b. Any set up conditions
 - c. The action to be taken
 - d. The expected outcome
 - e. A place to check off that the expected outcome did indeed occur
 - f. A place for the tester and the Project Manager's witness to sign and date the test sheet

D. Discrepancy Report

1. The test procedure shall also include a “discrepancy action report”. Any time an expected outcome does not occur the test shall immediately stop. The discrepancy action report shall log:
 - a. The step of the test that failed
 - b. The cause of the failure
 - c. The action taken to correct the failure
 - d. A place for the tester and the Project Manager to date and initial the report
2. One discrepancy action report shall be completed for each failure
3. After a failure, the Project Manager, may require that the entire test procedure be repeated, or may require only certain pertinent steps of the test procedure to be repeated.
4. When the test is completed and all test data sheets are dated and signed, the test data sheets shall be submitted to the Project Manager for Approval.

E. Test Reports and Records

1. Test reports shall be prepared for all tests and shall be submitted to the Project Manager within 10 days after completion of the tests for Approval. Reports shall include test methods followed, values of all test results, unusual conditions found, resolutions to any problems, serial numbers and calibration dates from all test equipment used, certification of passage of the test and copies of all check-off drawings or sheets used.
2. Copies of all adjustment or setting values shall be submitted to the Project Manager prior to submitting the system for Street Car Completion.
3. Certificates of compliance with factory test reports shall precede all shipments.

2.6 SIGNAL SYSTEM INTEGRATION TESTS

- A. After the Contractor has completed installation tests and verified system operation within the local limits of work, the following tests shall be performed, at a minimum, utilizing light rail vehicles and any other the Agency system elements as necessary:
 1. Interlocking Tests shall be performed to verify system safety through dynamic operation of passenger vehicles. Tests shall thoroughly exercise automatic signal and route clearing, Vetag-initiated routing and routing via the local control panel. The Contractor shall test all mainline to mainline movements.
 2. TWC tests shall be performed to verify proper TWC operation as designed. Tests shall thoroughly exercise all functions of Vetag at all locations, as indicated on the Contract Drawings.
- B. System Interface Tests
 1. The Contractor shall test all interfaces between existing systems and the work performed under this Contract to verify that there have been no adverse effects on safety or proper operation of the existing systems.

PART 3 - EXECUTION**3.1 TESTS**

- A. The Contractor shall conduct all tests in accordance with the approved test plan and procedures. Except as otherwise specified, the Contractor shall furnish all labor and materials necessary to perform tests, record data and prepare reports. Tests shall demonstrate compliance with the requirements of these Specifications. Any changes required to bring the systems into compliance shall be at no additional cost to the Agency, including the costs for additional testing. After the completion of a test, the Contractor shall remove all test equipment and temporary facilities and restore all systems to full operational status.

3.2 TRAINS FOR TESTING

- A. The Agency will provide trains with crews to support the testing program. The Contractor shall schedule test trains at least one week in advance using the Agency's standard application/approval procedure. Trains for testing will normally be scheduled 8 hours per day, 5 days per week, with the 1st hour of each day reserved for track inspection and setting up test limits, and the last 30 minutes reserved to bring the operating crew to the yard.

PART 4 - MEASUREMENT AND PAYMENT**4.1 MEASUREMENT**

- A. The quantities of accepted work will be measured in the following units. All measurements will be plan measure except for authorized changes.
1. Description: Lump Sum

4.2 PAYMENT

- A. Payment will be made at the respective unit or lump-sum price listed in the proposal and shall be full compensation for all labor, materials, and equipment necessary to complete the respective unit in place. There will be no separate measurement or payment for any item of work not specifically identified and listed in the proposal, and all such work shall be considered a subsidiary item with all costs pertaining thereto included in the prices for other items listed in the proposal. At the Engineer's option, partial payment may be made for any lump sum item listed in the proposal, providing that the Contractor is diligently and satisfactorily pursuing full completion of such partially complete item in accordance with the approved job progress schedule.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 41 22 00**HOISTS AND CRANES****PART 1 - GENERAL**

The General Provisions of the Contract, including General and Special Conditions and the requirements of Division 1, apply to the Work in this Section.

1.01 WORK INCLUDED

- A. Equipment items as listed below by Equipment Identifier:
 - 1. 5208 Crane, jib, foundation insert mounted, 7.5 ton, 19 foot span, motorized mast (Ref. Part 2.01)
 - 2. 5392 Hoist, chain, electric, motorized trolley, 2 ton (Ref. Part 2.02)
 - 3. 5397A Hoist, chain, electric, motorized trolley, 7.5 ton (Ref. Part 2.03)
 - 4. 5397B Hoist, chain, electric, motorized trolley, 7.5 ton (Ref. Part 2.04)
- B. Roughing-in, installation of equipment, and final connection of utilities, with labor, services, and incidentals necessary for complete and operational equipment installation.
- C. Wiring, and switching between equipment and utilities.

1.02 QUALITY ASSURANCE

- A. Equipment shall be produced by a manufacturer of established reputation with a minimum of five years experience supplying specified equipment.
- B. Manufacturer's Representative:
 - 1. Installation: Provide a qualified manufacturer's representative at site to supervise work related to equipment installation, check out, and start up.
 - 2. Training: Provide technical representative to provide training to Owner's maintenance personnel in operation and maintenance of specified equipment.
 - 3. Quality standards shall meet or exceed ISO-9001.

1.03 SUBMITTALS

- A. Product Data: Submit Product Data in accordance with Division 1 of these specifications.
- B. Operations and Maintenance Manual:
 - 1. Submit Operations and Maintenance Manuals in accordance with Division 1- General Requirements of these specifications.
 - 2. Provide complete parts, operating, and maintenance manual covering equipment at time of installation.
 - 3. Description of system and components.
 - 4. Schematic diagrams of electrical, plumbing, and compressed air system.

5. Manufacturer's printed operating instructions.
 6. Printed listing of periodic preventive maintenance items and recommended frequency to validate warranties. Failure to provide maintenance information will indicate that preventive maintenance is not a condition for validation of warranties.
- C. Shop Drawings: Submit Shop Drawings in accordance with Division 1.

1.04 PRODUCT SUBSTITUTIONS

- A. Follow requirements specified in Division 1 - General Requirements.
- B. Additional costs resulting from substitution of products other than those specified, by model number, including drawing changes and construction, will be at the expense of the Contractor.
- C. Substitution Approval: Prior to delivery or installation, submittals for each equipment item by Equipment Identifier shall be provided in accordance with Division 1 - General Requirements. Acceptance will be based on the technical requirements herein as determined by Owner and Architect.

1.05 WARRANTY

- A. Warrant work specified herein for one year from substantial completion against defects in materials, functions, and workmanship.
- B. Warranty shall include materials and labor necessary to correct defects.
- C. Defects shall include, but not be limited to noisy, rough or substandard operation; loose, damaged, and missing parts; and abnormal deterioration of finish. Defects shall not include damage due to neglect, misuse, or situations resulting from non-performance of a manufacturer's recommended preventive maintenance schedule.
- D. Submit warranties in accordance with Division 1 - General Requirements of these specifications.
- E. All parts shall be readily available locally in the United States.

1.06 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver equipment in manufacturer's containers, appropriately packaged and/or crated for protection during domestic shipment and storage in humid and/or dusty conditions.
- B. Indelibly label all containers, including those contained in others, on outside with item description(s) per title and Equipment Identifier of this specification.
- C. Provide equipment and material specified complete in one shipment for each equipment item. Split or partial shipments are not permissible.

1.07 BUY AMERICA COMPLIANCE

- A. The Contractor shall comply with the applicable Buy America requirements set forth in 49 U.S.C. 5323(j) and the applicable regulations in 49 C.F.R. Part 661, as amended. If the Contractor procures any capital items with Federal funds, it is the Contractor's responsibility to obtain the Buy America certification required under such regulations.
- B. Reference Division 1 for Buy America provisions.

PART 2 - PRODUCTS

2.01 CRANE, JIB, FOUNDATION INSERT MOUNTED, 7.5 TON, 19 FOOT SPAN, MOTORIZED MAST Equipment Identifier: 5208

- A. Manufacturer's Reference:
 1. Prime manufacturer: Specifications are based on equipment identified herein by manufacturer's name and model to establish minimal acceptable standards of quality, features, performance, and construction.
 - a. Abell-Howe, Forest Park, IL (708) 366-4800
 - b. Model: J-904-360-W27FMD, 7.5 ton, 19 foot span
 2. Alternate manufacturers: *Contingent upon compliance with these specifications* and documentation requirements set forth in SUBMITTALS, equipment produced by other manufacturers, including the following, *may* be considered as equal.
 - a. Yale Industrial Products, Forest City, AR (501) 633-2250
 - b. Gobel, Fishers, NY (585) 924-6262
- B. Capacities/Dimensions:
 1. Lifting capacity: 7.5 tons
 2. Dimensions:
 - a. Boom span (center of pivot to boom end): 19 feet
 - b. Boom length: 21 feet, 5 inches
 - c. Boom depth: 27 inches
 - d. Clearance under boom: 10 feet, 6 inches
 - e. Mast height: 12 feet, 9-1/4 inches
 3. Swing: 180 degrees
 4. Weight (nominal): 9,980 pounds
 5. Weight, hoist/trolley (maximum): 2,250 pounds
 6. Mast motor: 1/2 HP
- C. Features/Performance/Construction
 1. Mounting plate, and anchor bolts shall be provided by manufacturer. (See shop drawings for anchor bolt pattern.)

2. Crane boom shall be of American standard I-beam construction with trolley stops at both ends.
 3. Crane mast head:
 - a. Mast head shall be of a steel plate box type welded construction or seamless tubing.
 - b. Mast head assembly shall surround mast on a sleeve principle with mating surfaces carried on upper and lower bearings.
 4. Mast shall be a structural steel pipe with wall thickness sized for minimum deflection. Mast shall be equipped with stops to insure boom does not over swing.
 5. Crane shall be able to swing a maximum of 360 degrees. Crane stops shall prevent any portion of the boom, hoist, or tagline system from coming in contact with the building structure or walls. Verify placement of stops in the field.
 6. Crane shall have 7.5 ton hoist (Equipment Item 5397) mounted to boom.
 7. Mast shall be motorized.
- D. Accessories: Crane shall include a tagline assembly with cable rings.
- E. Utility requirements:
1. Electrical: 460 VAC, 3 phase, 1/2 HP
- F. Finish: Crane finish shall be a durable enamel in manufacturer's standard color.
- 2.02 HOIST, CHAIN, ELECTRIC, MOTORIZED TROLLEY, 2 TON
Equipment Identifier: 5392
- A. Manufacturer's Reference:
1. Prime manufacturer: Specifications are based on equipment identified herein by manufacturer's name and model to establish minimal acceptable standards of quality, features, performance, and construction.
 - a. Coffing Hoist, Wadesboro, NC (704) 694-2156
 - b. Model: ECMT4008-3-with 26 foot lift, 2 ton hoist with low speed trolley and accessories
 2. Alternate manufacturers: *Contingent upon compliance with these specifications* and documentation requirements set forth in SUBMITTALS, equipment produced by other manufacturers, including the following, *may* be considered as equal.
 - a. Lift-Tech International, Inc., Muskegon, MI (231) 733-0821
 - b. Yale Hoists, Inc., Forrest City, AR (501) 633-2250
- B. Capacities/Dimensions:
1. Hoist:

- a. Lifting capacity: 2 tons
 - b. Motor: 1 HP
 - c. Lifting speed: 8 FPM
 - d. Lifting range: Verify with monorail
 - e. Headroom, with trolley: 20 inches (maximum)
2. Trolley:
 - a. Capacity: 2 tons
 - b. Motor: 1/4 HP
 - c. Travel speed: 35 FPM
 - d. I-beam size range: 6 to 18 inches, American Standard Section
 3. Weight: 213 pounds (represents 10 foot lift)
- C. Features/Performance/Construction:
1. Hoist shall have needle and ball type bearings with gears running in oil bath.
 2. Frame shall be cast aluminum alloy.
 3. Load hook and chain: Hook shall be forged steel with safety clip and shall be attached to cadmium plated chain by bearing type swivel.
 4. Safety: Safety features shall include ratches pawl mechanical load brake, overheating, and positive limit switches.
 5. Hoist mounting: Hoist shall be lug mounted to trolley for minimum headroom.
 6. Pendant height: Pendant shall hang 36 inches above finished floor.
 7. Hoist shall be mounted on monorail as shown on Equipment Layout Drawing Q102.
- D. Controls: Four push button, radio controlled, for hoist UP/DOWN and trolley FORWARD/REVERSE
- E. Accessories:
1. Chain container: Mounted to hoist, Coffing Hoist No. 927JG18
 2. Conductor Bar System: Duct-o-wire, (800) 735-1922
- F. Utility Requirements:
1. Electrical: 460 VAC, 3 phase, 1-1/4 HP
- 2.03 HOIST, CHAIN, ELECTRIC, MOTORIZED TROLLEY, 7.5 TON
Equipment Identifier: 5397-A
- A. Manufacturer's Reference:
1. Prime manufacturer: Specifications are based on equipment identified herein by manufacturer's name and model to establish minimal acceptable standards of quality, features, performance, and construction.

- a. Coffing Hoist, Wadesboro, NY (704) 694-2156
 - b. Model: CM 5291M, 7.5 ton hoist with low speed trolley and accessories
 2. Alternate manufacturers: *Contingent upon compliance with these specifications* and documentation requirements set forth in SUBMITTALS, equipment produced by other manufacturers, including the following, *may* be considered as equal.
 - a. KCI Konecranes, Inc., Santa Fe Springs, CA (562) 903-1371
 - b. Yale Industrial Products, Inc., Forest City, AR (501) 633-2250
- B. Capacities/Dimensions:
 1. Hoist:
 - a. Lifting capacity: 7.5 tons
 - b. Motor: 5-3/4 HP
 - c. Lifting speed: 10 FPM
 - d. Lifting range: 10 feet
 - e. Headroom, with trolley: 34-5/8 inches
 2. Trolley:
 - a. Capacity: 7.5 tons
 - b. Motor: 1/4 HP
 - c. Travel speed: 35 FPM
 - d. Control cable length: 33 feet
 - e. I-beam size range: 6 to 18 inches, American Standard Section
 3. Weight: 870 pounds (represents 10 feet lift)
- C. Features/Performance/Construction:
 1. Hoist shall have needle and ball type bearings with gears running in oil bath.
 2. Frame shall be cast aluminum alloy.
 3. Load hook and chain: Hook shall be forged steel with safety clip and shall be attached to cadmium plated chain by bearing type swivel.
 4. Safety: Safety features shall include ratchet pawl mechanical load brake, overheating, and positive limit switches.
 5. Hoist mounting: Hoist shall be lug mounted to trolley for minimum headroom.
 6. Pendant height: Pendant shall hang 36 inches above finished floor.
 7. Hoist shall be mounted on jib crane, as shown on Equipment Detail Drawing Q101.
- D. Controls:
 1. Four pushbutton pendant, with cord strain relief bushings, for hoist UP/DOWN and trolley FORWARD/REVERSE

E. Accessories:

1. Festoon kit: CM No. 3566
2. Chain container: Mounted to hoist, CM No. 5242
3. Power cable length: 33 feet

F. Utility Requirements:

1. Electrical: 460 VAC, 3 phase, 6 HP

2.04 HOIST, CHAIN, ELECTRIC, MOTORIZED TROLLEY, 7.5 TON
Equipment Identifier: 5397-B

A. Manufacturer's Reference:

1. Prime manufacturer: Specifications are based on equipment identified herein by manufacturer's name and model to establish minimal acceptable standards of quality, features, performance, and construction.
 - a. Coffing Hoist, Wadesboro, NY (704) 694-2156
 - b. Model: CM 5291M, 7.5 ton hoist with low speed trolley and accessories
2. Alternate manufacturers: *Contingent upon compliance with these specifications* and documentation requirements set forth in SUBMITTALS, equipment produced by other manufacturers, including the following, *may* be considered as equal.
 - a. KCI Konecranes, Inc., Santa Fe Springs, CA (562) 903-1371
 - b. Yale Industrial Products, Inc., Forest City, AR (501) 633-2250

B. Capacities/Dimensions:

1. Hoist:
 - a. Lifting capacity: 7.5 tons
 - b. Motor: 5-3/4 HP
 - c. Lifting speed: 10 FPM
 - d. Lifting range: 14 feet
 - e. Headroom, with trolley: 34-5/8 inches
 - f. Finish: Exterior grade
2. Trolley:
 - a. Capacity: 7.5 tons
 - b. Motor: 1/4 HP
 - c. Travel speed: 35 FPM
 - d. Control cable length: 33 feet
 - e. I-beam size range: 6 to 18 inches, American Standard Section
 - f. Finish: Exterior grade

3. Weight: 870 pounds (represents 10 feet lift)
- C. Features/Performance/Construction:
1. Hoist shall have needle and ball type bearings with gears running in oil bath.
 2. Frame shall be cast aluminum alloy.
 3. Load hook and chain: Hook shall be forged steel with safety clip and shall be attached to cadmium plated chain by bearing type swivel.
 4. Safety: Safety features shall include ratchet pawl mechanical load brake, overheating, and positive limit switches.
 5. Hoist mounting: Hoist shall be lug mounted to trolley for minimum headroom.
 6. Pendant height: Pendant shall hang 36 inches above finished floor.
 7. Hoist shall be mounted on monorail, as shown on Equipment Detail Drawing Q101.
- D. Controls:
1. Four pushbutton pendant, with cord strain relief bushings, for hoist UP/DOWN and trolley FORWARD/REVERSE
- E. Accessories:
1. Festoon kit: CM No. 3566
 2. Chain container: Mounted to hoist, CM No. 5242
 3. Power cable length: 33 feet
- F. Utility Requirements:
1. Electrical: 460 VAC, 3 phase, 6 HP
- G. Finish: Finish shall be for exterior application.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Coordinate location of rough-in work and utility stub-outs to assure match with equipment to be installed.
- B. Inspect delivered equipment for damage from shipping and exposure to weather. Compare delivered equipment with packing lists and specifications to assure receipt of all equipment items and specified accessories.

3.02 INSTALLATION

- A. Perform work under direct supervision of Foreman of Construction Superintendent with authority to coordinate installation of scheduled equipment with Architect or designated representative.

- B. Install equipment in accordance with plans, shop drawings, and manufacturer's instructions:
 - 1. Positioning: Place equipment in accordance with any noted special positioning requirements generally level (or slight slope as required by instructions), plumb, and at right angles to adjacent work.
 - 2. Fitting: Where field cutting or trimming is necessary, perform in a neat, accurate, professional manner without damaging equipment or adjacent work.
 - 3. Anchorage: Attach equipment as directed by Architect or designated representative. Installation fasteners shall be installed to avoid scratching or damaging adjacent surfaces.
- C. Upon completion of work, finish surfaces shall be free of tool marks, scratches, blemishes, and stains.

3.03 TESTING

- A. After final installation is complete and prior to authorizing payment, specified equipment shall be checked with specifications in the presence of the Architect or designated representative using acceptance procedures provided by the manufacturer.

3.04 CLEANUP

- A. Touch-up damage to painted finishes.
- B. Wipe and clean equipment of any oil, grease, and solvents, and make ready for use.
- C. Clean area around equipment installation and remove packing and installation debris from job site.
- D. Notify Architect or designated representative for acceptance inspection.

3.05 TRAINING

- A. Direct the technical representative to provide specified hours of training to designated Owner's maintenance personnel in operation and maintenance of the following equipment. Coordinate, with Owner, training schedule and list of personnel to be trained.
 - 1. 5208 Crane, jib, foundation insert mounted, 7.5 ton, 19 foot span, motorized mast; 4 hours (minimum)
 - 2. 5392 Hoist, chain, electric, motorized trolley, 2 ton; 2 hours (minimum)
 - 3. 5397A Hoist, chain, electric, motorized trolley, 7.5 ton; 2 hours (minimum)
 - 4. 5397B Hoist, chain, electric, motorized trolley, 7.5 ton; 2 hours (minimum)

- A. Obtain, from technical representative, a list of Owner's personnel trained in equipment operations and maintenance.

END OF SECTION 41 22 00

SECTION 45 39 00**FABRICATED EQUIPMENT****PART 1 - GENERAL**

The General Provisions of the Contract, including General and Special Conditions and the requirements of Division 1, apply to the Work in this Section.

1.01 WORK INCLUDED

- A. Equipment items as listed below by Equipment Identifier:
 - 1. 1447 Rack, storage, stand, HVAC (Ref. Part 2.01)
 - 2. 1448 Rack, storage, truck (Ref. Part 2.02)
 - 3. 1860 Workbench, severe use, 6 feet (Ref. Part 2.03)
- B. Installation of equipment with labor, services, and incidentals necessary for complete and operational equipment installation.

1.02 QUALITY ASSURANCE

- A. Equipment shall be manufactured by a manufacturer of established reputation with a minimum of five years experience performing similar fabrication techniques.

1.03 SUBMITTALS

- A. Shop Drawings shall be submitted in accordance with Division 1 - General Requirements of these specifications.

1.04 PRODUCT SUBSTITUTIONS

- A. Follow requirements specified in Division 1 - General Requirements.
- B. Additional costs resulting from substitution of products other than those specified, by model number, including drawing changes and construction, will be at the expense of the Contractor.
- C. Substitution Approval: Prior to delivery or installation, submittals for each equipment item by Equipment Identifier shall be provided in accordance with Division 1 - General Requirements. Acceptance will be based on the technical requirements herein as determined by Owner and Architect.

1.05 WARRANTY

- A. Warrant work specified herein for one year from substantial completion against defects in materials, functions, and workmanship.
- B. Warranty shall include materials and labor necessary to correct defects.

- C. Defects shall include, but not be limited to noisy, rough or substandard operation; loose, damaged, and missing parts; and abnormal deterioration of finish. Defects shall not include damage due to neglect, misuse, or situations resulting from non-performance of a manufacturer's recommended preventive maintenance schedule.
- D. Submit warranties in accordance with Division 1 - General Requirements of these specifications.

1.06 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver equipment in manufacturer's containers, appropriately packaged and/or crated for protection during domestic shipment and storage in humid and/or dusty conditions.
- B. Indelibly label all containers, including those contained in others, on outside with item description(s) per title and Equipment Identifier of this specification.
- C. Provide equipment and material specified complete in one shipment for each equipment item. Split or partial shipments are not permissible.

1.07 BUY AMERICA COMPLIANCE

- A. The Contractor shall comply with the applicable Buy America requirements set forth in 49 U.S.C. 5323(j) and the applicable regulations in 49 C.F.R. Part 661, as amended. If the Contractor procures any capital items with Federal funds, it is the Contractor's responsibility to obtain the Buy America certification required under such regulations.
- B. Reference Division 1 for Buy America provisions.

PART 2 - PRODUCTS

2.01 RACK, STORAGE, STAND, HVAC Equipment Identifier: 1447

- A. Manufacturer's Reference: Fabricated item as shown on Equipment Detail Drawing Q500.
- B. Contractor shall confirm size of HVAC unit with car manufacturer prior to fabrication.
- C. Capacities/Dimensions:
 - 1. Load capacity: 2,000 pounds
 - 2. Overall dimensions:
 - a. Length: 100 inches
 - b. Width: 72 inches
 - c. Height: 60 inches
- D. Features/Performance/Construction:

1. Legs: Rack legs shall be fabricated of 3 by 3 by 3/16 inch steel tube.
 2. Leg braces: Leg braces shall be 3 by 3 by 3/16 and 6 by 3 by 3/16 inch steel tube continuously welded.
 3. Feet platforms: Feet platforms shall be 3/8 inch steel plates with continuous welds to tubing.
 4. Casters: Casters shall be 6 inches.
 5. Welds: All welds shall conform to American Welding Society standards.
- E. Finish: Cover all exposed steel surfaces including legs, braces, and feet platforms with one coat of zinc chromate primer and two coats of epoxy per manufacturer's recommendations in Owner's choice of color.
- 2.02 RACK, STORAGE, TRUCK
Equipment Identifier: 1448
- A. Manufacturer's Reference: Fabricated item as shown on Equipment Detail Drawing Q500.
 - B. Contractor shall confirm size of trucks with car manufacturer prior to fabrication.
 - C. Capacities/Dimensions:
 1. Load capacity: 12,000 pounds
 2. Overall dimensions:
 - a. Length: 94-1/4 inches
 - b. Width: 65-1/2 inches
 - c. Height: 68-1/8 inches
 - D. Features/Performance/Construction:
 1. Frame/Bracing: Bracing shall be fabricated of 3 by 3 by 3/16 inch steel tube.
 2. Gusset Plates: Gusset plates shall be 1/2 inch steel plate continuously welded to tubing - 8 total.
 3. Side Plates: Plates shall be 1 inch steel plate with continuous welds to tubing - 4 total.
 4. Welds: All welds shall conform to American Welding Society standards.
 - E. Finish: Cover all exposed steel surfaces including braces and legs with one coat of zinc chromate primer and two coats of epoxy per manufacturer's recommendations in Owner's choice of color.
- 2.03 WORKBENCH, SEVERE USE, 6 FEET
Equipment Identifier: 1860
- A. Manufacturer's Reference: Fabricated item as shown on Equipment Detail Drawing Q500.
 - B. Capacities/Dimensions:

1. Load capacity: 2,500 pounds
 2. Work surface thickness: 3/8 inch
 3. Overall dimensions:
 - a. Length: 72 inches
 - b. Depth: 32 inches
 - c. Height: 34 inches
- C. Features/Performance/Construction:
1. Legs: Workbench legs shall be fabricated of 3 by 3 by 3/16 inch steel tube.
 2. Leg braces: Leg braces shall be 3 by 1/4 inch steel plate continuously welded to tubing.
 3. Top braces: Top braces shall be 3 by 3 by 1/4 inch steel angle with continuous electrical welds to tubing.
 4. Top: Top shall be 3/8 inch steel plate with 50 percent minimum electrical welds to top braces. Corners of top shall have a 2 inch radius for protection of personnel. All edges shall be ground smooth.
 5. Skid plate: Skid plate shall be 4 by 4 by 1/4 inches steel plate with continuous welds to tubing.
 6. Welds: All welds shall conform to American Welding Society standards.
- D. Finish: Cover all exposed steel surfaces including both sides of top, braces, and legs with one coat of zinc chromate primer and two coats of epoxy per manufacturer's recommendations in Owner's choice of color.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Coordinate location of rough-in work and utility stub-outs to assure match with equipment to be installed.
- B. Inspect delivered equipment for damage from shipping and exposure to weather. Compare delivered equipment with packing lists and specifications to assure receipt of all equipment items and specified accessories.

3.02 INSTALLATION

- A. Perform work under direct supervision of Foreman of Construction Superintendent with authority to coordinate installation of scheduled equipment with Architect.
- B. Install equipment in accordance with plans, shop drawings, and manufacturer's instructions:
 1. Positioning: Place equipment in accordance with any noted special positioning requirements generally level (or slight slope as required by instructions), plumb, and at right angles to adjacent work.

2. Fitting: Where field cutting or trimming is necessary, perform in a neat, accurate, professional manner without damaging equipment or adjacent work.
 3. Anchorage: Attach equipment as directed by Architect or designated representative. Installation fasteners shall be installed to avoid scratching or damaging adjacent surfaces.
- C. Upon completion of work, finish surfaces shall be free of tool marks, scratches, blemishes, and stains.

3.03 TESTING

- A. After final connections are made and prior to authorizing payment, specified equipment shall be tested for compliance with specifications in the presence of the Architect or designated representative using acceptance procedures provided by the manufacturer.

3.04 CLEANUP

- A. Touch-up damage to painted finishes.
- B. Wipe and clean equipment of any oil, grease, and solvents, and make ready for use.
- C. Clean area around equipment installation and remove packing and installation debris from job site.
- D. Notify Architect or designated representative for acceptance inspection.

END OF SECTION 45 39 00